ADVENTURES IN TROPICAL SCIENCE FOR JUNIORS

Book 4

Adventures in Tropical Science for Juniors

N. A. WATTS
B.SC., B.T., A.B.T.I.

Book 4

Illustrated by T. Majumder

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FOREWORD

MOST young children come to school eager to learn. They are alive with curiosity, on edge to explore, among other things, the wonderland of Nature, animate and inanimate. Nature Study has rightly been since the beginning of this century an essential part of the curriculum of the Junior School child; but, unfortunately, it has in too many instances meant largely a dictated series of notes to be learnt by rote rather than a real, vital contact with Nature's wonders. And even where a good text-book has replaced the exercise book filled with dictated notes, it has been generally a text-book written for English or American children, which, while excellent in itself, has had little relevance to the Indian child.

To improve and make more relevant to Indian conditions the teaching of Nature Study or Junior School Science in Anglo-Indian Schools in West Bengal, an expert Committee met in 1954 under my Chairmanship to draft a suitable graded syllabus and suggest suitable methods of teaching this important subject in the Junior School. The outcome of its findings was published by Orient Longmans in a pamphlet entitled 'Suggestions for the Teaching of Nature Study and General Science in Schools in India.'

Mr. Watts, who was an active member of the above Committee, has based his series of admirable text-books on the syllabus and methods outlined in the above pamphlet, and has done an excellent job of work. His series of text-books appears to me to be particularly well-suited to the needs and interests of young children in India, and will, I am sure, prove stimulating both to children and to teachers not only in Anglo-Indian Schools but in other types of progressive schools all over India and in similar regions.

Adventures in Tropical Science fills a gap in the text-book field, and I am sure will be warmly welcomed by teachers and children. I wish it every success.

AUSTIN A. D'SOUZA, M.A., B.T.,
DIP.ED. (LOND.), A.I.E. (LOND.)
Inspector of Anglo-Indian Schools, West Bengal

ADVENTURES IN TROPICAL SCIENCE

FOR JUNIORS

A simple introductory series
to the study of General Science
for schools in India

Book 1.	For pupils up to the age of 8
Book 2.	,, ,, ,, ,, ,, ,, ,, 9
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PREFACE

THE conception of science taught in the primary school must not be falsified or distorted by an exaggerated importance placed on the accumulation of knowledge to be acquired and crude, inert blocks of data to be stored. The subject must be planned along lines that are vivid and unencumbered by the dead-wood of a formal tradition, quickened by inquiry, initiative and ingenuity; refusing to be distracted by methods which have for their criterion an attachment to conventional orthodoxies, rather than an appraisement of the essential needs and possibilities of the children themselves. New avenues should be explored, by which the pupils leave the beaten path and strike out fearlessly, predominated by curiosity, into new fields: which is the very soul of education. Assimilation and appreciation of science must be a lively, realistic process, cultivating the imagination and fostering social spirit; a stream in motion, not a stagnant pool.

In composing the five books in this series the author does not pretend to have made any startling discoveries or to have enunciated novel truths; rather is this an attempt to create and instil in the minds of children, according to their maturity levels, a provocative interest and an understanding of the wonder and variety of the world in which they live. Sedulously applied it may be expected to impart a meaning and motive to the child's initial experience of the miracle of life.

The teacher must formulate a philosophy of teaching adjusted to suit the conditions and needs of the neighbourhood. It should be flexible, adaptable and developing in its nature, subject to modification with the introduction of new evidence. In the ultimate analysis, each method of teaching should appeal to the emotion of the children, relying less on mass-instruction and more on the encouragement of individual and co-operative effort, resulting in the pooling of material and ideas, so that the school may be regarded not as the antithesis of life, but as its complement and commentary.

N. A. WATTS

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I

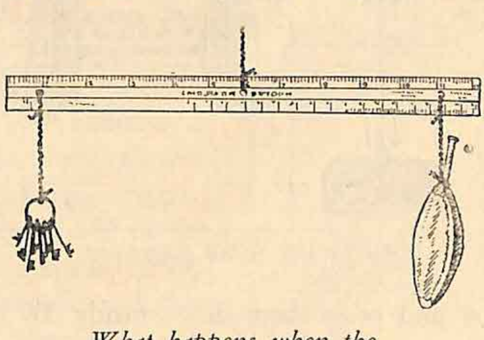
Tricks with Air Pressure

LIKE the fish of the ocean man lives in the midst of another kind of ocean — an ocean of air, called the atmosphere. This great ocean surrounds the earth, covering it like a gigantic blanket.

Without the atmosphere there would be no animal or plant life; no winds, clouds or rain and no fire. Our earth would be much like the moon around which there is no air.

The ocean of air around us has many moods. Sometimes it is gentle and at other times dreadful. Who knows how it will blow in the next minute? It finds its way into every nook and cranny. Even if we empty a box or bottle of its contents we may be sure that air enters in immediately.

Air is like everything else on our earth in one respect — it has weight. Place an empty football bladder at one end of a scale with small weights at



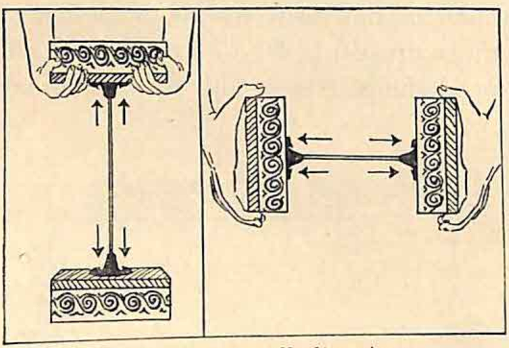
What happens when the bladder is filled with air?

the other end to balance it. Pump air into the bladder. Is it still balanced by the same weight?

If disturbed in any way, the ocean of air becomes very rough. Then it furiously rages through the neighbourhood dashing and shaking everything in its path with great noise and commotion. When behaving in this way we are made aware that moving air exerts a considerable pressure, for often huts and even huge trees are pushed down.

Does air press on things when it is still? In an earlier experiment it was proved that air had weight, consequently it must have pressure. Here are a number of tricks that you can perform at home. If you follow the directions carefully, the pressure of the air will make your tricks a success.

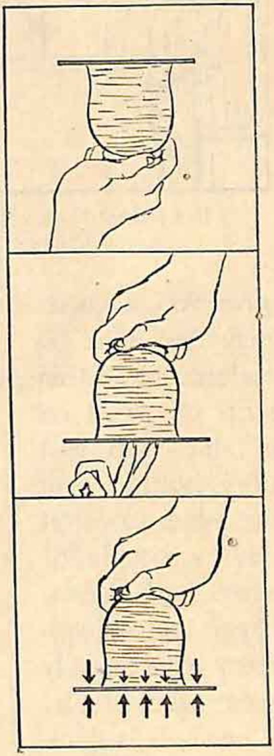
Make a sucker by cutting a piece of thick leather in the shape of a circle. Pierce a hole through the centre and pass a string through it. Tie the end of the string to a tiny stick below. In the same way fix the other end of the string to another sucker. Wet the suckers thoroughly by soaking them in water. Put each sucker on a flat tin box and press them down firmly. By doing this you will be pressing out all the air from under them. Lift one of the boxes so that the other tin box dangles from the second sucker. Try to separate the suckers from the boxes by pulling them sideways.



Air presses in all directions

You will not find it easy. The suckers do not come away for the air presses on them. This trick teaches us a remarkable fact about air pressure: that air presses in all directions. To release the sucker from the box lift part of the edge. Now air will enter and push it away from the surface of the box.

Household creatures such as the gecko and fly have suckers on their feet which help them to run over glass panes. It is air pressure that enables them to remain upside-down on the ceiling.

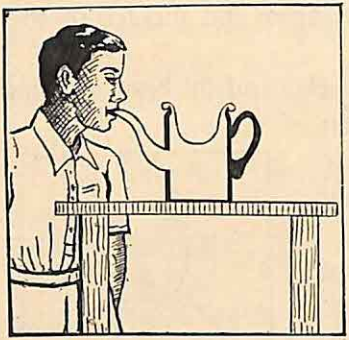


The tumbler trick

Fill a tumbler up to the brim with water. Place a piece of thin cardboard over the top, making sure that there are no air bubbles below. Put your fingers over the cardboard to keep it steady and invert the tumbler. Remove your fingers from the cardboard. The air pressure acting upwards on the cardboard keeps the water in the tumbler. What do you think will happen if you allow a little air into the tumbler? Try it and see.

Here is a way by which you can test your strength against a friend of your own size. Push on either side of an open door and see who gives way first. Whoever pushes harder will win this trial of strength. It is the same with air pressure. On a still day the air pushes equally on either side of a

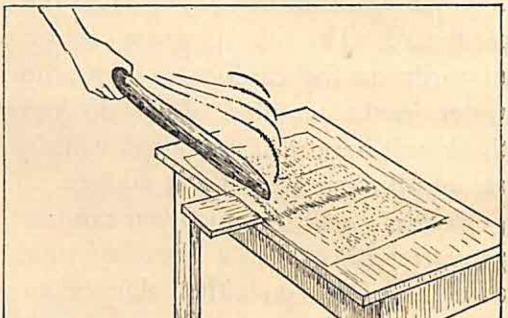
door and it does not move. On a windy day, however, the pressure on one side is stronger than the pressure on the other side. When this happens the door bangs.



Why does the rubber sheet cave in?

Cover the mouth of a coffee-pot with a sheet of rubber cut from a balloon. Tie it on tightly with string. Remove as much air as you can by sucking at the spout. The pressure on the two sides of the sheet is now unequal. As the air pressure on the outside is greater than the pressure of the air remaining in the coffee-pot, the rubber sheet will cave in.

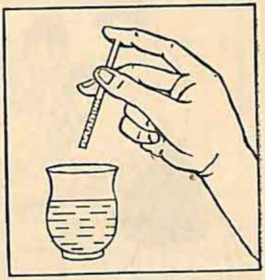
A trick which will serve to give you a good idea of the enormous pressure of the air may be done as follows. Lay a thin strip of wood on a table with part of it jutting over the edge. Cover it with a couple of sheets of newspaper and smooth them out carefully over the table. When this is done give the piece of wood that sticks out a hard swift blow with a heavy cudgel. The pressure of the atmosphere does not allow



Using air pressure to break a wooden strip

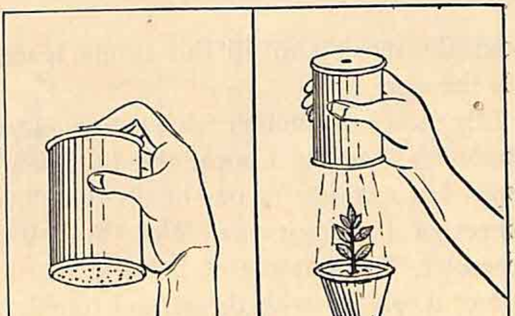
the paper to be lifted and the wood snaps in two as if the other end were nailed to the table. If you were to push down slowly on the strip, instead of hitting it, the newspaper would go up because you would then be giving the air a chance to flow underneath and raise the paper.

Dip a glass tube into a tumbler of water. Put a finger over the top end and take the tube out. Air pressure acts on the surface of the water at the lower end, keeping the water in the tube. If you then remove your finger the water flows out.



What keeps the water in the tube

The Magic Water-Sprinkler works along the same lines. Make one out of a tin that has a press-in type of lid. Punch a single hole through the lid and a number of holes through the bottom of the tin. Put the tin into a tub of water and fill it. Place a finger over the single hole and lift it out from the tub. Air pressure keeps the water inside the tin. When you take away your finger the water flows out.



The Magic Water-Sprinkler

A vacuum is the name given by scientists to a gap in the air. It is an absolutely empty space. There are

not many vacuums to be found in our world, for the moment they occur air rushes in to fill them. Here are a few ways to have fun, making vacuums and watching what happens when air tries to enter.

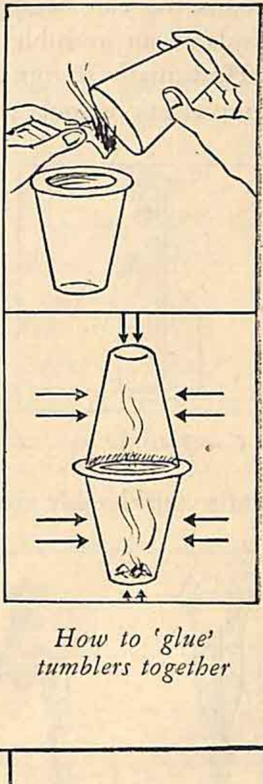
Obtain a medium-sized bottle and an egg. Boil the egg hard and then carefully remove the shell. Next drop into the bottle, a piece of burning paper and after waiting for a couple of seconds place the egg in the mouth of the bottle. If you have chosen a bottle of the correct size the egg should fit into the mouth as if it were an egg-cup. The burning paper creates a vacuum and the air on the outside, seeking to fill this empty space, rushes inside driving in the egg.

The egg trick

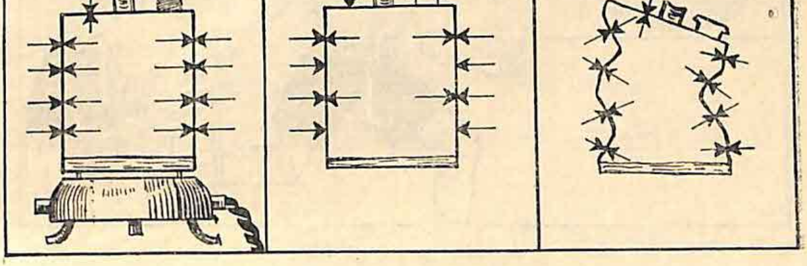
By means of another trick with a vacuum, you can 'glue' two tumblers together. Choose two tumblers which are of the same size. Cut a collar for one of the tumblers out of a double-sided sheet of blotting-paper. Wet the collar and place it over a tumbler. Toss a piece of burning paper into the tumbler and cover it quickly with the second tumbler so that their rims are one above the other. After the paper stops burning you will see that both tumblers are stuck together. The burning paper

forms a partial vacuum and the air, in attempting to push inside, joins the two tumblers. The collar acts as a seal and keeps out the air.

Find an empty petrol can and make sure that not a drop of petrol is left in it. Remove the stopper and pour in half a cup of water. Set the can over a stove and heat the water for several minutes. When the water in the can boils, the steam formed drives out most of the air from the inside of the can. Replace the stopper and allow the can to cool. As the steam cools it changes to water and a partial vacuum forms within. The small amount of air in the can exerts a very small pressure on the tin sides which is no match for the atmospheric pressure working from the outside. Finally, with creaks and



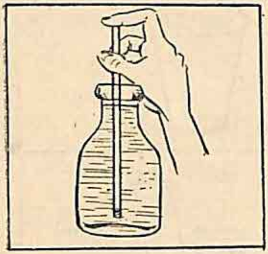
How to 'glue' tumblers together



Air pressure versus partial vacuum

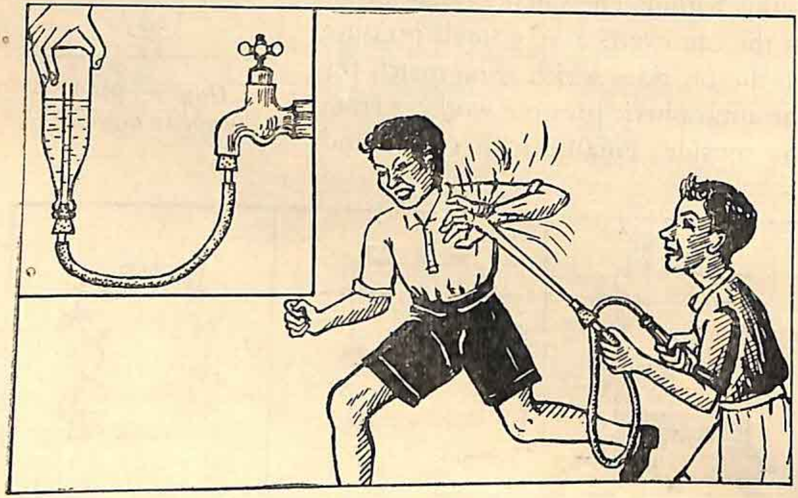
groans the can begins to crumple, crushed as it were in the hands of an invisible giant.

How many things can you name which are elastic? If anything elastic is squeezed out of shape it has a tendency to spring back into shape when the pressure acting on it is removed. Before we prove that air is elastic, let us first see how it may be compressed.



Compressing air

Take a glass tube and close one end with your finger. Press it down into a large bottle of water, open-end first. You will notice that though no air escapes, a little water rises in the tube. When air is squeezed in this way it exerts considerably more pressure than it usually does. The force



The Automatic Squirter
Inset: refilling the squirter

of this increased pressure, due to the elastic nature of the air, can be seen in the Automatic Squirter.

Fit a one-holed stopper, a glass tube and a rubber tube to a bottle. At the other end of the rubber tube fit another glass tube and a one-holed stopper to a tap. Open the tap gently and allow water to pour into the bottle. When the bottle is half full turn off the tap. Pinch the rubber tube with your thumb and finger and remove the tube from the tap. Invert the bottle. As you release your hold on the rubber tubing, the compressed air in the bottle pushes the water out with great force.

Man has studied the atmosphere for centuries. During this time he has learned many interesting things about his invisible companion. Most of these facts he has turned to his own purpose, and invented many useful gadgets and machines to make life more comfortable. In this chapter you have read a few truths about this wonderful gas which is, indeed, the very breath of life.

Things to make and do

Outdoors:

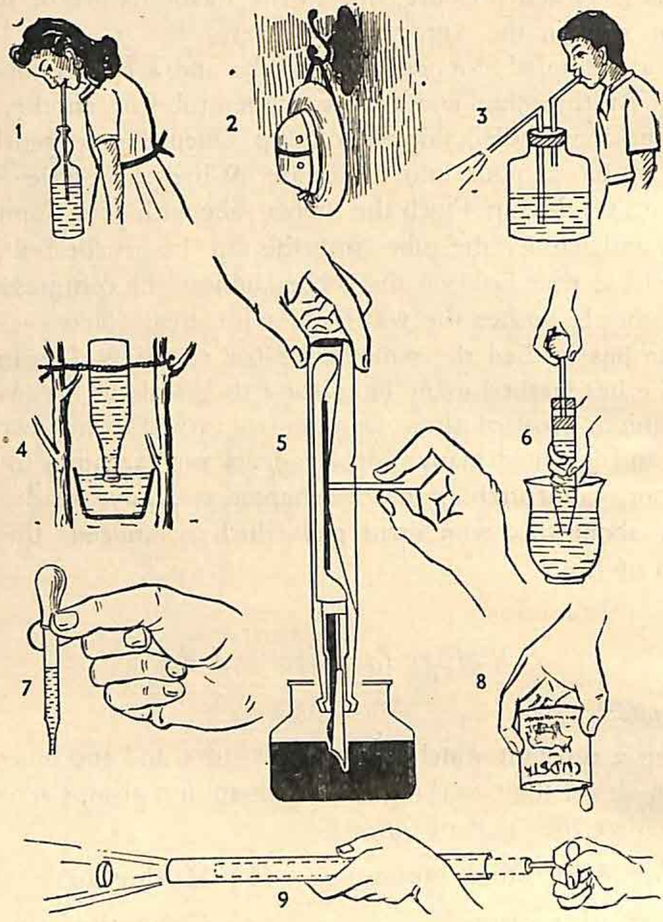
Keep a constant watch for gadgets, toys and machines that rely on air for their working. Divide them into groups according to whether they depend on:

(*a*) Air for their support. (*b*) Moving air.

(*c*) Air pressure. (*d*) Compressed air.

For your wall newspaper:

Copy the drawings on page 10 and put in arrows to show the direction in which air presses.



Draw arrows to show the direction of air pressure
1. Enjoying a cool drink. 2. A rack without nails. 3. A wash bottle. 4. A fountain for fowls. 5. A fountain-pen. 6. A syringe. 7. A fountain-pen filler. 8. A tin of condensed milk. 9. A popgun shooting potato bullets.

In your note-book:

Describe how air pressure helps the things pictured on page 10 to work.

Have a Magic Show:

Get your friends together and perform some of the tricks mentioned in this chapter.

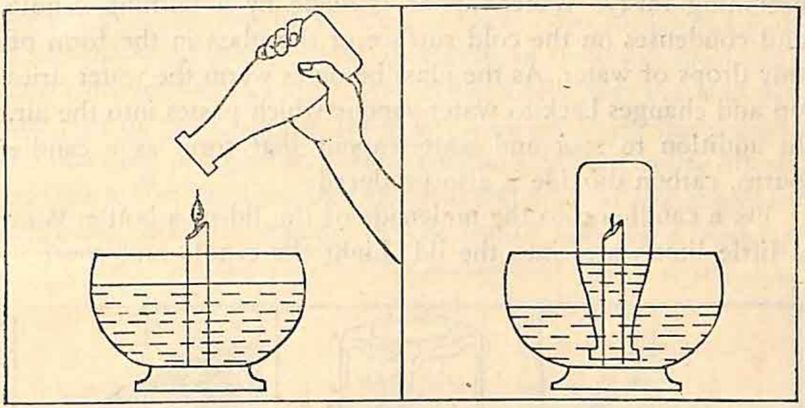
2

The Secret of the Air

As we continue our study of science, the common and everyday happenings in our lives take on a new meaning. We are able more clearly to understand what we see. By performing simple experiments we learn many interesting and often unexpected facts about things we once thought we knew so well. The familiar things about us have many secrets to reveal to those who examine them carefully and seek to find out more about them. So it is with man's study of air. Almost two centuries ago the air gave us its most important secret — that it was not one gas but a mixture of many gases.

At home you can perform an easy experiment which will help you to discover for yourself the truth of this statement.

Ask Mother for a candle and fasten it to the bottom of a bowl with a little melted wax. Pour some water into the bowl. Set the candle alight and cover it over with a milk bottle. The candle continues to burn for a short while and then gradually goes out. You will now observe that something remarkable has happened. The water in the bowl has entered the bottle and risen a little way. For this to have happened it must mean that part of the air was used up by the burning candle and that water took its place. Part of the air in the bottle allowed the candle to burn in it and part did not. We must therefore



Oxygen is used in burning

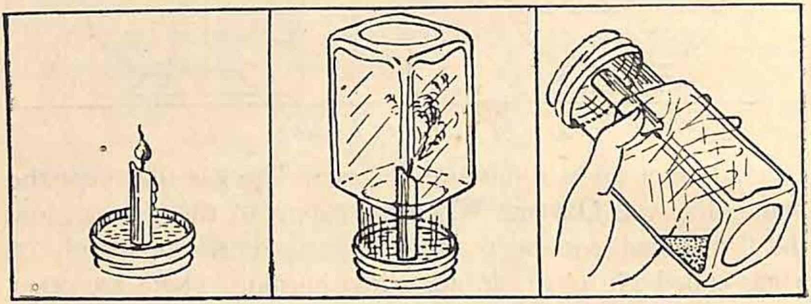
conclude that air is a mixture of gases. The gas that kept the flame alive was Oxygen. When the supply of this gas ran low the flame died, for the remaining gases, consisting mainly of a gas called Nitrogen, do not allow burning. There are other gases present in the air in small quantities, the chief of which is one called Carbon Dioxide.

Before you can prove that carbon dioxide is present in the air, some lime-water will have to be prepared. Obtain some lime and mix it with water. Filter the mixture, collecting the clear water in a bottle. The lime-water you have made becomes milky when carbon dioxide is mixed with it. Leave a little lime-water in a saucer for a few days on a shelf and it will become milky due to the presence of carbon dioxide in the air.

Let us study a burning candle in more detail and see exactly what happens. When a candle burns the solid wax melts and smoke is given off. If you hold a piece of glass over the flame it is soon covered with a black coating known as soot. Before this covering of soot appeared you must have noticed the glass

becoming misty. Water-vapour is made by a burning candle and condenses on the cold surface of the glass in the form of tiny drops of water. As the glass becomes warm the water dries up and changes back to water-vapour which passes into the air. In addition to soot and water-vapour that form as a candle burns, carbon dioxide is also produced.

Fix a candle on to the underside of the lid of a bottle. Pour a little lime-water into the lid. Light the candle and cover it



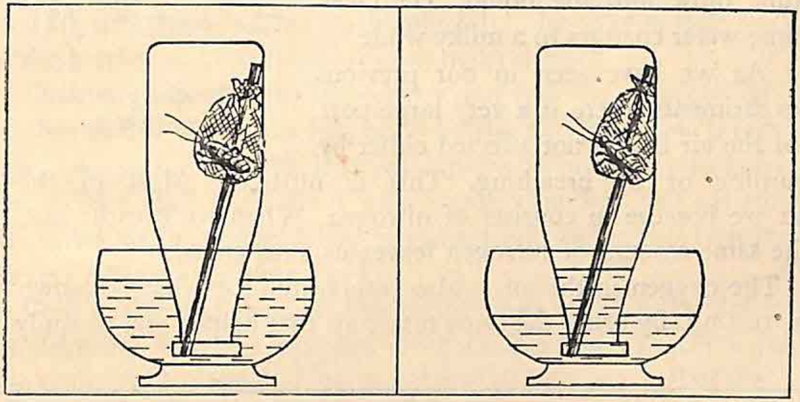
Carbon dioxide is produced when a candle burns

over with the bottle, screwing the bottle into the lid as you do so. The candle soon goes out for it uses up the oxygen of the air in the bottle. Gently turn the bottle upside down and slowly shake the liquid round in the bottle. The lime-water becomes milky because carbon dioxide was produced by the burning candle. What is true of a burning candle is also true of the burning of such things as wood, paper, oil and coal.

Burning and breathing have much in common between them. At first this seems a very odd thing to say, yet by doing the experiments that follow you will reach this conclusion.

Capture a few insects and put them into a small bag made from mosquito netting. Cockroaches will do very well as they

are pests. Tie the bag to the top of a stick. Now fill a bowl with water and stand the stick with its bundle of insects in the water. Cover it over with a milk bottle. After a few days you will see that part of the air in the bottle has been used and water from the bowl has occupied its place. Gradually lift the bottle allowing the water in it to flow out. Immediately slip a piece of cardboard over the mouth of the bottle. Plunge a burning



Oxygen is used in breathing

splinter of wood into the bottle. The gases that remain in the bottle do not allow the splinter to burn. This shows that in breathing, the insects used up all the oxygen that was present in their supply or air.

All living things breathe air into their bodies continually. It is the oxygen part of the air that is needed and this is taken from the air during the process of breathing. To understand this vital activity still further, you may experiment with your own breath, and test the air you breathe out.

Stand in front of a mirror and breathe on to it. The cool surface at once becomes misty. As with the burning

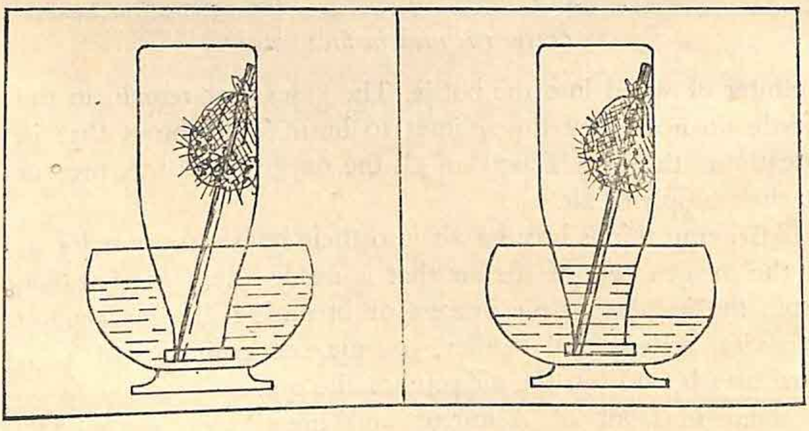
candle water-vapour is a product of breathing.

You can prove quite simply that some of the gas you breathe out is also the same as that made by a candle when it burns. Pour a little lime-water into a tumbler and by means of a glass tube blow into the liquid. The clear lime-water changes to a milky white.

Breathing into lime water

As we have seen in our previous experiments, there is a very large part of the air that is not affected either by burning or by breathing. This is nitrogen. Most of the air we breathe in consists of nitrogen. When we breathe out, the same amount of nitrogen leaves us, unchanged.

The oxygen in the air is also responsible for what is known as rusting. By using the same materials that helped you to study



Oxygen is used in rusting

the process of breathing and by setting them up in the same fashion, you can prove that oxygen is taken from the air when iron rusts. Substitute for the insects in the bag a few bright iron nails. Moisten the nails with water and wait for the results. After some days you will find that water has entered the milk bottle. The water will rise to the same height as it did during similar experiments that you performed when studying burning and breathing. Test for oxygen with a burning splinter. You will see that there is none of the gas left. The oxygen that was in the bottle has joined with iron to make it rust.

That iron will not rust if kept dry and free from oxygen can be seen in this way. Take two small bottles and put a few bright iron nails in each. In the first put a piece of quicklime to keep the air dry. Fill the second with water, that has had all the dissolved air in it expelled by boiling. Cork the bottles tightly. Examine the nails after a week.

Both in this and the last chapter you have seen how by doing experiments with the simplest of materials you can come to the same conclusions that famous scientists have reached in their study of the air. You have been let into many secrets of the mysterious gas around us. Just knowing the secret, however, is not enough. You must understand and try to perfect each experiment before you try the next. If you meet with failure in your attempts, look for the fault and correct it. Doing experiments is good fun and is the best way of discovering the solution of the mysteries of life.

Things to make and do

In and around your home:

It is the water-vapour in the air that moistens objects and

fittings made of iron. The oxygen of the air then proceeds to destroy the iron by gradually changing it into rust. To prevent the iron from rusting, coat the metal with oil, paint or grease. These things keep the water-vapour and the oxygen of the air from uniting themselves with the iron.

For your wall newspaper:

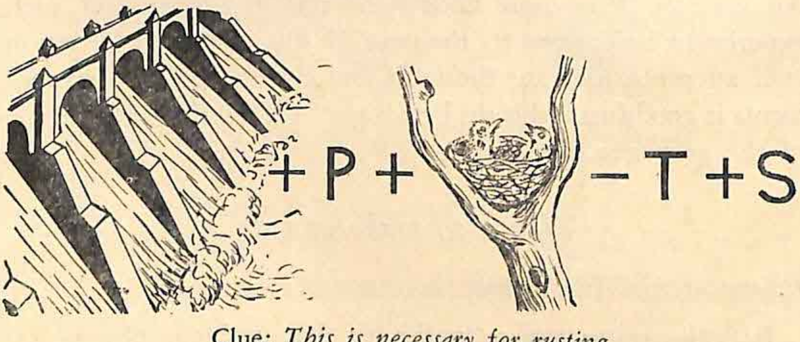
Make a graphical picture of the contents of the air. Divide a large sheet of paper into a hundred equal squares. Shade in 78 squares to represent nitrogen, 20 squares to represent oxygen, one square to represent water-vapour and another square to represent carbon dioxide and the other minor gases of the air. Use different colours to make your shading more effective.

In your note-book:

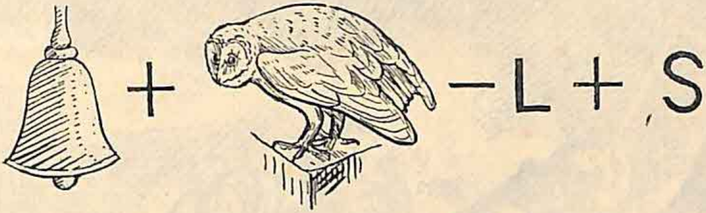
Make a comparison of burning, breathing and rusting. Point out any differences and similarities there are in these processes.

Picture Puzzle:

The pictures in the following puzzles suggest certain words. Add and subtract the letters of these words to the other letters in the puzzles, as indicated.

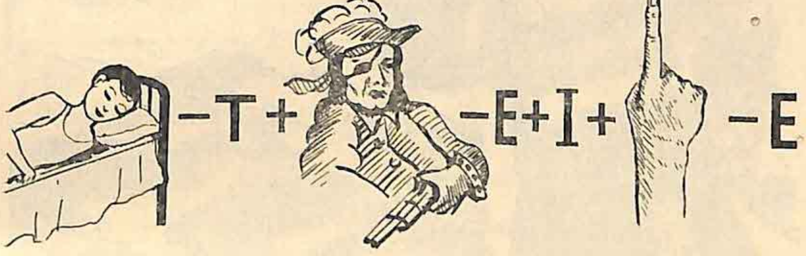


Clue: *This is necessary for rusting*



Clue: *An instrument used by a blacksmith to blow up his fire*

Clue: *An air-borne disease*



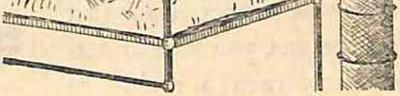
Clue: *Another name for breathing*

Climbing to dizzy heights

3

More about Invisible Gases

HIGH up on top of the world, two men struggled against the smooth white face of Everest. With the aid of ice-picks they clung dangerously and desperately to the mountainside in their bid to be the first men to conquer the lofty mountain. Masks covered their faces and cans containing gas were strapped to their backs. A few more staggering steps and they stood on the summit of the mighty Himalayan giant. The heroes of this amazing adventure were 'Tiger' Tenzing of India and Hillary of New Zealand. The gas they carried with them was Oxygen. Without this wonder gas it would have been impossible for them to have reached their goal.

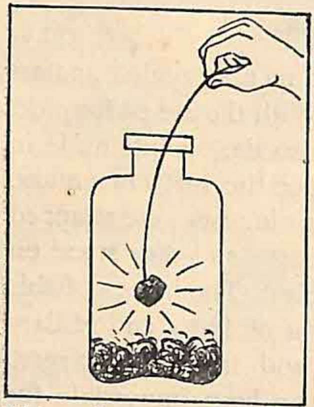


An oxygen tent

Mountaineers and airmen who go far above the earth take with them a supply of oxygen, for here the air is not plentiful and they find it difficult to breathe. In hospitals too, this gas is used by doctors. A person suffering from damaged lungs is not able to breathe very well. The oxygen he takes in is not enough

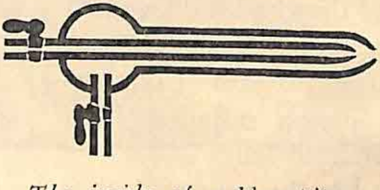
for his needs. The patient is laid in bed and a special tent placed over his face. Oxygen from a container is passed into the tent. Under these conditions he receives treatment. When he is quite well the tent is removed and he can breathe ordinary air again.

Look for hydrogen peroxide and a bottle of Condys (potassium permanganate) in the medicine cupboard at home. Pour a little hydrogen peroxide into a bottle and add to it a pinch of Condys. Bubbles of oxygen will be seen coming from the mixture and the gas will soon fill the bottle. Do not bother to look for the gas for you will not see it. Thrust into the bottle a glowing splinter and it will burst into flame. Take a small lump of charcoal and wind the end of a piece of wire around it. Heat the charcoal until it is red hot and then lower it into the gas. It will give off sparks and crackle merrily as it burns with a brighter light.



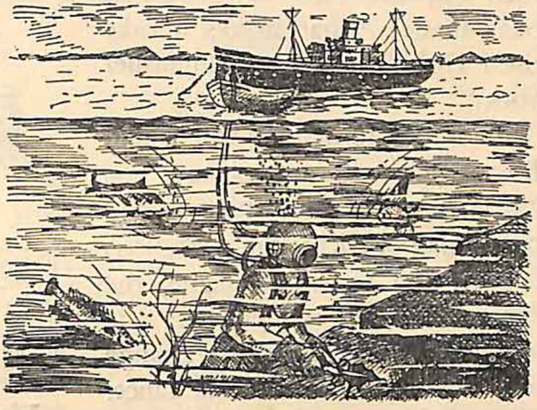
Things burn brightly in oxygen

Experiments with the glowing splinter and the red hot lump of charcoal teach us that substances burn more brightly in oxygen than they do in air. If you remember this fact about the gas, you will understand how men are able to cut through thick iron and steel plates as easily as a knife cuts through butter. The



The inside of a blow-pipe

instrument that is used for such a purpose is called a blow-pipe. Acetylene, a gas, is passed through one of the side pipes of the instrument. Unlike oxygen, this gas burns. Through the second pipe oxygen is supplied to make the acetylene burn with a very hot flame. Sheets of iron and steel cannot withstand the heat from this flame and are



Cutting through the sides of a ship

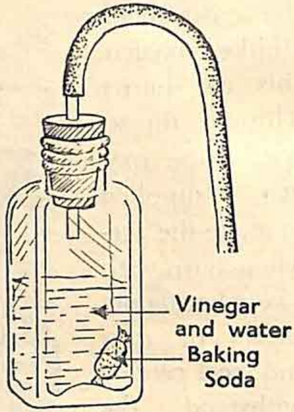
cut in two. If a ship carrying valuable cargo suffers shipwreck and sinks, divers are sent down into the sea. With their oxy-acetylene blow-pipes they cut a hole through the iron sides of the ship, enter within and recover the cargo.

Welding

The oxy-acetylene flame is also used to join two pieces of iron. The terrific heat of the flame melts the ends and when they are softened in this way they stick together. This process is called welding.

Experimenting with carbon dioxide at home will give you the answers to many

questions that may have puzzled you in the past. Why does a bottle of soda-water fizz when opened? How are ice-cream sodas made? What makes a cake 'rise'? How does a fire extinguisher work?

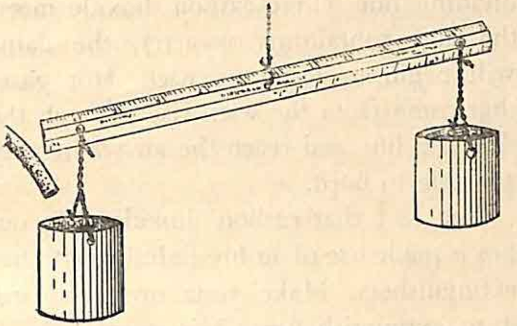


The carbon dioxide supply-bottle

In addition to helping you to find the answers to these problems, you will learn a few more stunts to add to your bag of tricks: the mysterious balance; the vanishing flame; the home-made fire extinguisher; the carbon-dioxide cannon; the strange soda-fountain; mothballs that dance. These and others which you may be able to invent yourself are possible once you have understood a few important facts about the gas.

You will need a bottle, baking soda (sodium bicarbonate) vinegar, water, tissue paper, a one-holed stopper, glass and rubber tubes to help you set up the apparatus needed to provide you with a ready supply of carbon dioxide. Mix vinegar and water in equal parts and pour the mixture into the bottle to fill half of it. Fix the glass tube into the stopper and attach the rubber tube to it. Make a packet of baking soda by wrapping the powder in tissue paper. Drop the packet into the bottle and put the stopper on quickly. When the contents of the bottle bubble, colourless carbon dioxide will come forth from the rubber tube.

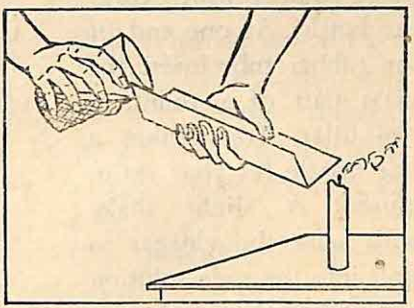
Tie two large tins to the ends of a ruler so that they balance perfectly. Pour carbon dioxide into one of the tins by holding



The mysterious balance

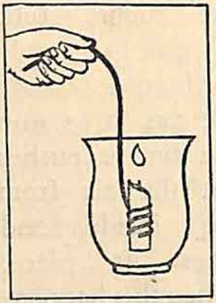
the rubber tube of your gas-supply bottle over it. As the gas flows into the tin it pushes out the air from the inside and takes its place. When this happens the tin goes down upsetting the balance of the ruler, showing thereby that the gas is heavier than the air contained in the other tin.

Light a candle and set it on a table. Fill half a tumbler with vinegar and add a tea-spoonful of baking soda to the liquid. Although you can neither see nor smell it, carbon-dioxide fills the tumbler quickly. Pour the gas by means of a paper trough over the flame. Pouff! The flame goes out the moment the heavy gas sinks over it.



Pouff !

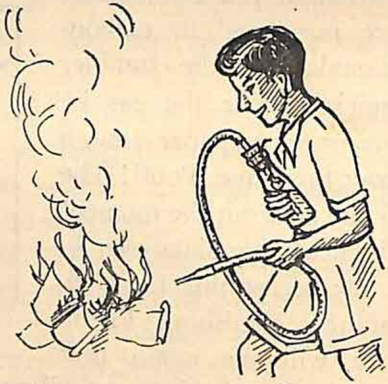
By performing the trick of the Vanishing Flame you will see again that carbon dioxide does not allow things to burn in it. Use your gas-supply bottle to fill half a tumbler with carbon dioxide. After a few failures you will soon learn how to do this successfully. Attach a lighted candle to a length of wire and gently lower it into the tumbler. You will see that at the



The vanishing flame

dividing line where carbon dioxide meets the air (containing oxygen), the flame will begin to leave its wick. Hot gases that come from the wick rise through the dividing line and reach the air where they are able to burn.

The fact that carbon dioxide puts out fire is made use of in fire fighting with fire extinguishers. Make your own and use it to extinguish fires. Mix a solution of baking soda in water and fill three-quarters of a large bottle with it. Fill a small bottle with vinegar and attach a string to its neck. Lower the bottle of vinegar so that it is above the soda solution and fix it to the mouth of the larger bottle as shown. Fit glass and rubber tubes to the one-holed stopper which corks the bottle. At one end of the rubber tube insert the glass part of a fountain-pen filler. This makes a fine nozzle for your extinguisher. A slight shake will cause the vinegar to spill into the soda solution and carbon dioxide begins forming. The gas exerts great pressure on the surface of the liquid and forces it out of the bottle. The liquid which squirts out of the nozzle is filled with carbon dioxide gas and is excellent for putting out a fire.



Make your own fire extinguisher

Soda-water is made by exerting considerable pressure on carbon dioxide and forcing it into water where it dissolves. When you remove the cap from a soda-water bottle the pressure is lessened and carbon dioxide comes fizzing out. How can we prove that the gas bubbles are those of carbon dioxide? Quite simply. Fit a glass tube and a one-holed stopper to the mouth of the bottle and test the gas by passing it through lime-water. The liquid turns milky. This is the usual test for carbon dioxide.

The pressure exerted by carbon dioxide can be shown by making a bottle-cannon. It is best to fit it together outdoors so that there will be no danger of smashing anything in the house. Use the same recipe for making the gas as you did before, with this difference: let there be no way for the gas to escape. When the soda mixes with the vinegar solution the gas produced sets up a terrific pressure which forces out the cork with a pop.

Waiting for the pop

Put two spoonfuls of baking powder in an ice-cream cup, moisten it with water and stir. Bubbles of carbon dioxide will make a 'Soda Fountain' for you and the mixture will froth and splutter over the sides of the cup. Bubbles of this gas are also responsible for making cakes rise. Baking powder plays an important part in the preparation of most cakes. When the powder is moistened, the gas that is given off pushes upwards and the cake rises. The next time Mother makes a cake try to find out how the holes in it are formed.

Now let us look into the problem of the dancing moth-balls which seem to move by themselves up and down in a tumbler containing a clear liquid. It is a strange sight and you can mystify your friends by setting up such a display on your desk at home. Mix equal quantities of vinegar and water in a tumbler and drop in two or three mothballs. Add very gently a spoonful of baking soda. Then watch and wait for the result. Very soon the balls begin to rise slowly, hesitate at the top and then go down again only to repeat their peculiar behaviour. What makes the mothballs dance? Surely you can guess?

Things to make and do

Visit a soda-water factory:

During your walk around the premises try to understand everything you see. Ask questions of the manager regarding the machinery and the process. Find out why carbon dioxide is dissolved in soda-water.

For your wall newspaper:

Write an account of your visit to the soda-water factory.

In your note-book:

Name the gas:

1. Suppose you are shown three jars, one containing air, another oxygen and another carbon dioxide. Mention one test which will help you to decide what each jar contains.

2. Pour a little fresh lime-juice on some washing soda contained in a bottle. Identify the gas that forms.

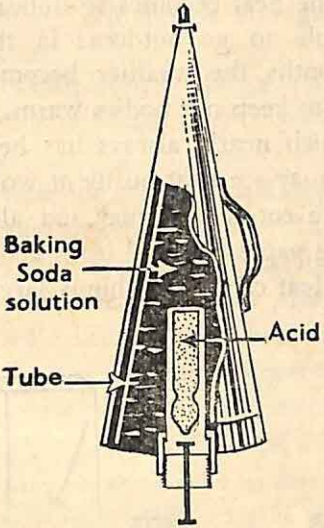
3. What gas is given off when health salts are put into water.

4. Take a used flashlight cell, break it open and remove the black substance contained inside it. This substance is manganese dioxide. Crush it into a powder. Pour a little hydrogen peroxide into a bottle and add a small quantity of the black powder. A gas bubbles out of the mixture. What is it?

5. Test the gas that comes forth when baking soda is heated.

How a fire extinguisher works:

A fire extinguisher is filled with a strong solution of baking soda. At the lower end above the plunger is a bottle containing acid. To work the extinguisher the bottom of it is banged and the plunger pushed inwards. This action results in the breaking of the bottle. When the acid comes in contact with the solution of baking soda a large quantity of carbon dioxide is produced. The gas exerts a pressure on the liquid forcing it up the side tube and out at the nozzle. The liquid quenches the fire and the gas smothers it.



The inside of a fire extinguisher

Draw a picture of a fire extinguisher with the bulb broken and liquid spraying out from its nozzle.

4

What Heat Can Do

ALL OF US who live in the tropics are familiar with the great heat our land receives from the sun in the summer months. At this time of the year the heat becomes so unbearable that it is most uncomfortable to go outdoors in the afternoon. During the winter months the weather becomes cold and woollen clothes are worn to keep our bodies warm.

At home there is one room which nearly always has heat in it. This is the kitchen. Here we may see heat busily at work doing things. The fire in the stove cooks our food and also makes things melt. In the following pages you will learn about something else that heat can do. Heat can make things larger and set liquids and gases moving.

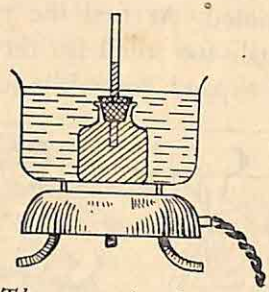
Find a length of thick iron wire to experiment with. You will also need an electric stove, a few bricks, an iron rod, a thin stick of wood and some sealing wax.

The iron wire expands when heated

Put the wire on a row of bricks so that one end presses against

a wall. Hold the wire down by placing bricks upon it. Place the other end of the wire over the rod with bricks below and above to keep it steady. Use hot sealing wax to attach the stick to one end of the rod. Mark the position of the stick by standing a cardboard box behind it. Heat the wire with the electric stove. The wire on receiving heat expands, rolling the rod and turning the stick. Mark the new position. Allow the wire to cool. You will find that as the wire cools it contracts, rolling the rod which in turn moves the stick back to its first position. All solids expand when heated and contract when cooled. Do liquids and gases behave in the same way? Let us see.

Completely fill a bottle with coloured water. Fit a one-holed stopper and glass tube to the bottle. Mark the level of water in the tube with gummed paper. Immerse the bottle in a metal vessel containing water. Gently warm the apparatus over a fire. As the water in the bottle is heated it swells up and the level of water in the glass tube rises. Stop heating and mark the new level. Watch what happens as the liquid cools. You will find that the water in the tube drops gradually and returns to its previous level. Yes, liquids, like solids, expand when heated and contract when cooled. We will now consider gases and see if they obey the same rule.

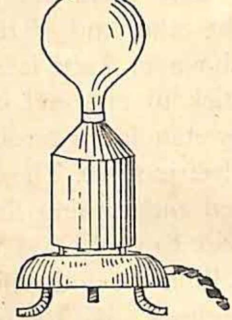


The water in the bottle expands when heated

Obtain a can with a narrow neck. Stretch the mouth of a balloon so that it fits over the neck of the can. Gently warm the can over a stove. On being heated the air inside it expands and goes into the balloon filling it. Stop heating and see the

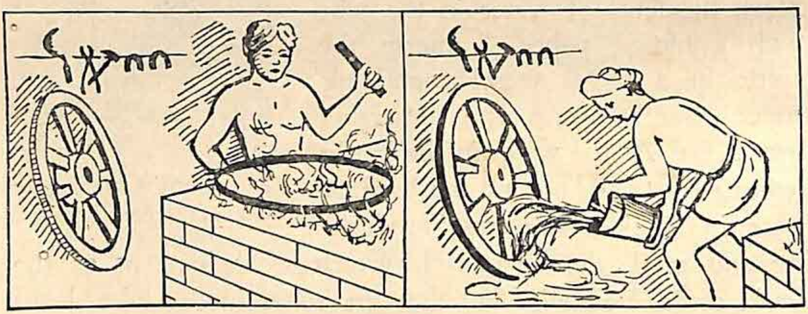
balloon shrivelling as the air inside it contracts on cooling and flows back into the can.

Suppose you repeat this experiment with a slight change. Heat the can and then fit on the balloon. What will you expect to see happening as the can cools?



The air in the can expands when heated

You may have noticed that the wheels of a bullock-cart have iron tyres. The wheelwright who fixes these tyres on to the wheel makes use of the fact that solids expand when heated and contract when cooled. At first the tyre is made just a little too small for the wheel. The tyre is then heated to make it expand, and while still hot is slipped on to the wheel. Buckets



A wheelwright at work

of water are thrown on to the metal tyre to cool it quickly. As the tyre cools it grips the wheel firmly.

The thermometer which the doctor puts into the mouth of his patient is an instrument that depends on the behaviour of liquids when heated. The silvery liquid in the bulb is called

mercury. When heated by the patient's body the mercury expands and its level rises.

A little boy was playing with a balloon when he was called to bed. Carelessly he left his balloon before a fire-place. A few minutes later his family were startled by a loud report. It was made by the balloon that had burst. The young owner did not understand how his toy had burst of its own accord. Do you?

There is no need for you to do this experiment to know the result. If you take a metal spoon in one hand and a wooden ruler in the other and plunge their ends into very hot water, you will soon drop the spoon. Heat travels along the spoon more rapidly than it does along the ruler. The metal spoon is said to be a good conductor of heat whereas the wooden ruler is a bad conductor of heat. Metals such as brass, tin, iron, lead etc. are all good conductors. Wool, stone, glass, wood, porcelain, water, air etc. are all bad conductors.

In the kitchen we use vessels made of metal to boil water. The heat from the stove is conducted easily through the metal and soon boils the water. On the other hand we prefer to drink hot tea from porcelain cups rather than metal mugs. Why?

Poor conductors are used to keep hot things hot and cold things cold. They are able to prevent heat from entering or escaping from whatever they cover. Feathers and fur prevent heat from leaving the bodies of animals that wear these poor conductors over their skins. If heat left their warm bodies they would feel cold. These coverings also trap a layer of air which, being a poor conductor, further helps to keep their bodies warm. Are these warm coats of any use to these animals in the summer?

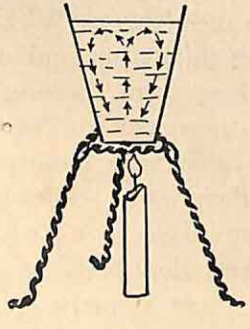
When you step out of bed in the morning you put your feet into slippers. If you were to walk on the floor without them,

your feet would feel cold. This is because the stone floor is a better conductor of heat than the leather of your slippers and it conducts the heat away from your feet faster than does the leather. The iron railings of a gate feel hotter in summer than the wooden framework. Iron carries heat to your hand more quickly than the wood and therefore feels hotter.

Hot water cracks a cold glass for exactly the same reason that cold water cracks a hot glass. When boiling water is poured into a tumbler the heat of the water makes the inside surface expand. Since glass is a poor conductor of heat the outside of the tumbler remains cool and does not expand. This unequal expansion of the two surfaces results in the cracking of the glass.

The movement of liquids and gases from one place to another is called a current. Here is a way to make currents at home and study the part heat plays in their formation.

Bend and twist fairly thick wire to make a stand as shown. Fill a Pyrex tumbler with water and set it on the stand. Put a little sawdust into the water. Although most of the sawdust floats on the surface some of it will sink to the bottom. Place a candle below the tumbler and light it. As the water above the flame is heated, it expands, becomes light and rises. Cold water from the sides of the tumbler takes the place of the water that has risen. The water that rises, on reaching the surface is cooled, contracts and, being heavier than the water that is pushing up from below, is forced

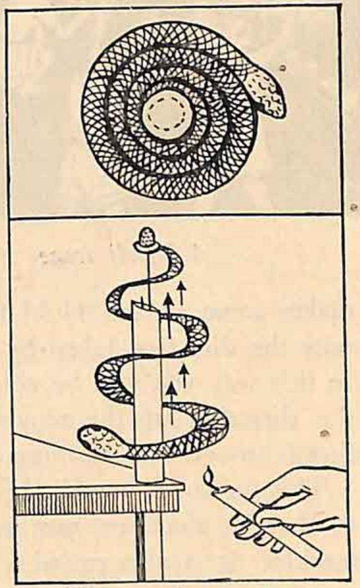


The arrows show the direction in which the sawdust moves

onwards. It moves in the only direction possible — that is downwards, along the sides of the tumbler. Now it meets the flame again and rises once more. By watching the movement of the sawdust in the water you will be able to observe this current which is called a convection current.

Since water is a bad conductor of heat it should take a long time to get heated. Yet this is not so. When a saucepan of water is placed over a stove the heat of the stove is carried from one place to another by convection currents, and the water boils in a few minutes.

Let us turn our attention to gases and see what heat does to them. We will experiment with air as it is easily available. The rotating snake is a toy that will take you a few minutes to put together and show you what hot air can do.

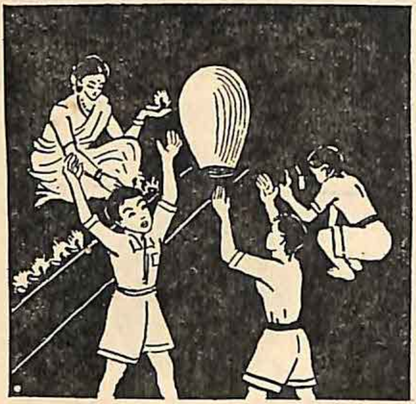


The rotating snake

Draw a snake on a sheet of stiff paper and cut out its shape with scissors. Put a candle on a table and at the top insert a needle. Balance a thimble on the needle and fix on the paper snake. Hold a lighted candle below. The heat from the flame makes the air above expand. This hot stream of air is lighter than cold air. From further away cold air presses round the flame pushing the hot, lighter air upwards, making the snake chase its tail.

The hot air balloons that float upwards into the sky during the festival of Divali look so mysterious as they sail away to unknown lands! Have you ever sent such a balloon on its way? Perhaps you can tell how it is made.

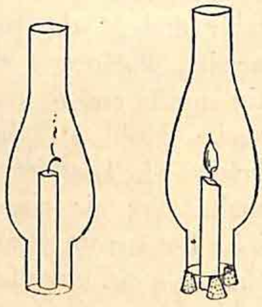
Place a lighted candle on the table and put a glass chimney around it. The flame soon goes out.



A Divali scene

Repeat this experiment with a slight change. Place the chimney on three corks so that it is well off the table. The flame now burns brightly. The air above the flame continues to be expelled, but now a supply of fresh air rushes under the chimney to take its place. Set fire to a piece of paper, and then blow it out so that it makes some smoke. Hold the paper below the chimney and note the direction taken by the smoke. In this way you will be able to follow the direction of the moving air that flows around the burning candle.

This current formed by heat is similar to the one that you saw in the pyrex tumbler. It is also called a convection current.



The chimney experiment

There is always need for a regular flow of fresh air into a room, or in other words, for good ventilation. Fresh air

brings oxygen which we use to breathe. The air we breathe in is warmed in our bodies and the warm gas we breathe out contains more carbon dioxide than it did before. This warm gas is pushed up by the cooler air that flows in to take its place. If there is no way for the warmer, lighter gas to escape, it will foul the room. The breathing in of this used air would lead to drowsiness and headaches. To prevent such discomfort windows called ventilators are built at the top of the room. It is through these ventilators that foul air escapes. Good care should be taken to have the ventilators always open, for fresh air is of great value to our health.

Heat is as important to us as food or water. Life on our earth would stop if there were too little heat or too much of it. It helps us to do many things and can be an obedient slave. The problem of producing heat easily has puzzled man through the ages. Today there are many ways of making heat quickly and with no bother at all. How many such ways can you name?

Things to make and do

Outdoors:

Look out for these examples of how heat affects the common things around you.

1. There are small spaces left between sections of railway lines. On a hot summer's day the rails expand and come close together at their ends. It is the space between them that prevents the rails from buckling.

2. Telegraph wires hang loosely in the hot-weather but are taut in winter.

3. When houses are built a space is left for the girders to expand, so that their expansion in the summer months may not damage the building.

4. If a kettle is filled to the brim with water, the liquid expands and overflows when heated.

5. Bicycle tyres sometimes burst if the machine is left in the hot midday sun. The heat from the sun makes the air in the tube expand and this causes the tyre to burst.

For your wall newspaper:

Draw a plan of an ill-ventilated house and another of one which has good ventilation. Show by means of arrows the direction of convection currents caused by people sitting in the two houses.

In your note-book:

You have no doubt asked many 'Whys' in your life. Now try answering these 'Whys'.

1. Why is ice kept in a box filled with sawdust?
2. Why is the metal cover of a bottle heated if it gets stuck to the bottle?
3. Why is it hotter above a candle flame than at the sides.
4. Why are woollen clothes worn in winter?
5. Why are hot dishes placed on cork mats?
6. Why does the flame of a candle lean towards the fire if placed before the fireplace?
7. Why are the handles of metal tea-pots made of wood?
8. Why are there openings below the chimney of a hurricane-lamp?
9. Why do the sparks of a bonfire go upwards?

10. Why are the iron bars in the grate of a fireplace made loose?

11. Why is it warmer in the galleries of a theatre (which is not air-conditioned) than in the stalls?

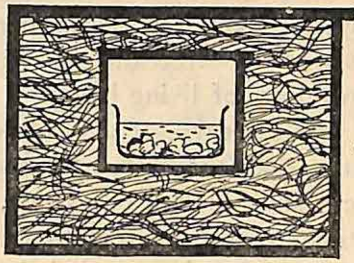
12. Why is it that on a cold morning a metal lock feels colder to the touch than a wooden desk in the same room?

13. Why does the smoke from a chimney rise straight into the air on a calm day?

14. Why is a tea-cosy used to cover hot tea-pots as well as cold ice-cream jars?

15. Why does a glass tumbler crack if ice-water is poured into it?

Make this straw-box:



A straw-box

A straw-box consists of two wooden boxes, one inside the other. The space between the two boxes is filled with straw. It is useful for keeping food hot and soda-water cool. The straw is a poor conductor of heat and so does not allow heat to enter or to escape from the inner box.

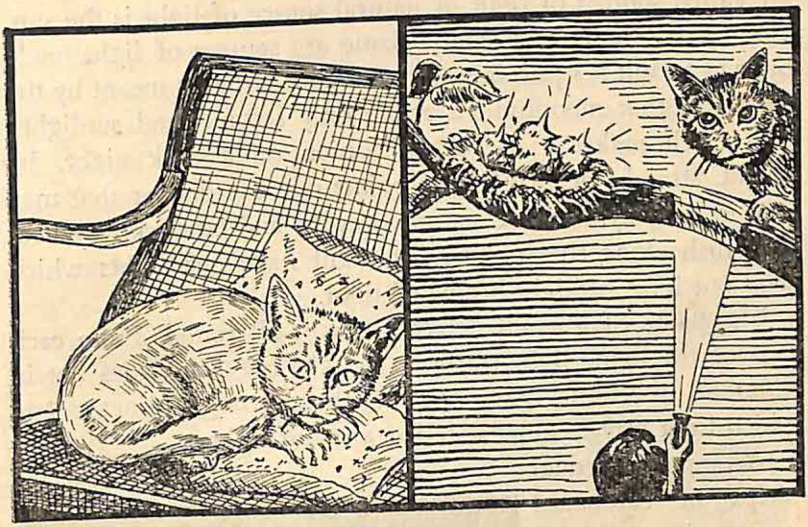
5

Light in Our Lives

BELOW the surface of the soil a number of tiny creatures dwell in a world of darkness. Born and bred underground they have no need for sight and are all blind. Animals that share with us the light of the sun are blessed with the wonderful gift of sight. The special parts of the body responsible for this important sensation are the eyes, which may be called the windows of living beings.

As the eaves of a window prevent rain from beating in, so also does the eyebrow prevent sweat from trickling into the eye and blurring our vision. Window-panes are cleaned from time to time with a cloth and soapy water. The eyelids perform this service for our 'windows'. Every few seconds they flick over the surface of the eye washing it with a tear. The eyelids help in yet another way. They keep most of the light from entering the eyes when closed. The shutters of a window stop light from entering a room. By adjusting the dark curtains of a window you can have as much light as you wish in a room. Our eyes have curtains too. They are beautifully coloured. Look at your eyes in the mirror. The dark spot in the centre, called the pupil, is the window. The coloured ring around it is the curtain. It is called the iris. In strong light the iris partly closes the pupil so that not much light can enter the eye.

Too strong a light has a blinding effect and is bad for the eyes. In dim light the iris makes the pupil larger so as to allow as much light as possible to enter the eye.



A cat's eyes

In the day *At night*

Cats are able to see in very dim light. Their pupils become large at night and their eyes can catch even the smallest amount of light. Behind the pupil is a little room which is round in shape. Here light pictures are made. In another book you will read how this is done.

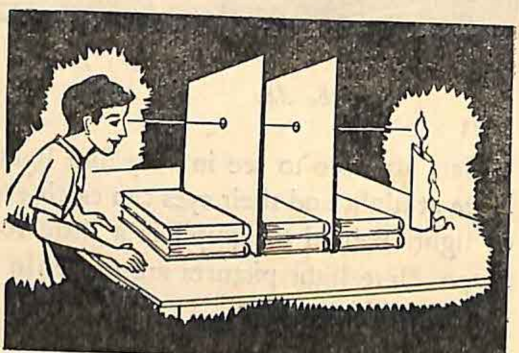
At eventide when the sun has set, the householder lights his lamps. The lowly villager lights a candle or a hurricane-lamp, while in the towns electric lights are switched on. Things which lie in the dark can be seen when light falls on them. The electric bulb gives off its own light but a chair in

the same room sends to our eyes borrowed light. The sun, a lighted electric lamp and a candle flame are examples of things that have the power of sending out light by themselves. They are called sources of light. A natural source of light is the sun. The electric lamp and candle flame are sources of light made by man to suit his purposes. Do you know what is meant by the statement that moonlight is really only second-hand sunlight?

A torch makes a useful companion on a dark night. Its bright, straight beam of light points out any danger that may lurk in the way. Motor-cars, motor-cycles and other conveyances that rush along the highway at night have headlights which send out long, straight beams of light.

The flame of a candle gives off light all round. From each part of the flame light starts in straight lines and goes out in different directions. Any one of these straight lines along which light travels may be called a ray of light.

Arrange two equal strips of cardboard over each other and pierce a hole through their centres. Support the two strips in an upright position with the help of books. Place one in front of the other. Put a lighted candle before one of them so that the flame is in line with the hole in the second strip of cardboard. The flame will be visible when it is in the same straight line as

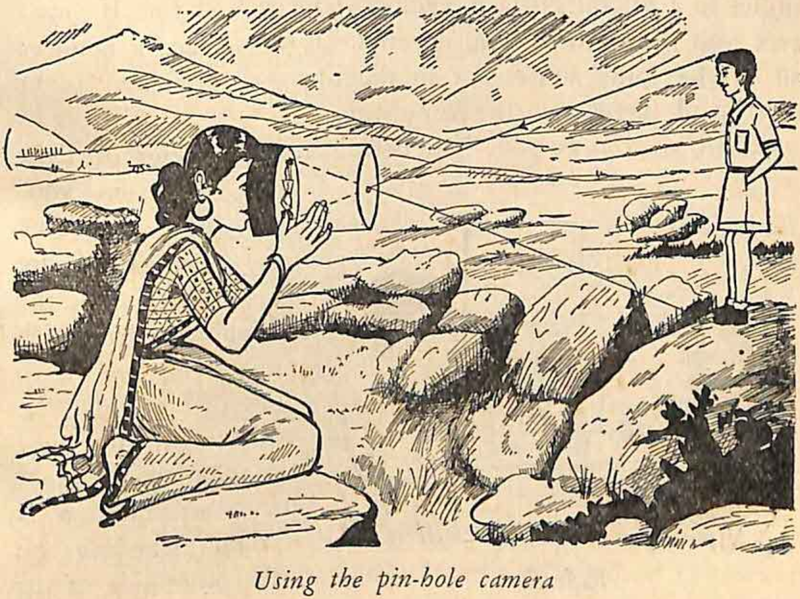


Light travels in straight lines

the two holes in the cardboard. If one of the strips be slightly moved the flame will not be seen. This simple experiment proves that light travels in straight lines.

Make a pin-hole camera from an empty tin. Punch a hole through the centre of the bottom using a strong needle. Stick carbon paper on the inside of the tin. Cover the open end with tissue paper and tie it on tightly with string. Roll thick, black paper round the box, fastening it on with rubber bands. See that the edges of the paper jut out on one side.

Point your pin-hole camera at a friend and look in from the other side. A picture of your friend standing on his head is seen on the tissue paper. Bearing in mind that light travels in straight lines it is not difficult to understand why this should happen.



Using the pin-hole camera

Among the favourite spots chosen for a picnic are the shady sides of a tank. How pleasant it is to sit by the calm cool water and gaze at the glories of the surrounding vegetation reflected in the mirror-like surface of the tank. There are other surfaces that reflect light in this way and show distinct pictures of objects. The mirror at home is made of clear glass coated with a material containing mercury. It reflects light excellently.

Some surfaces reflect light less perfectly than others. The white walls of a room reflect light very well. But a polished silver tea-pot reflects light even better and you can see your face in its surface. Almost everything around us reflects the light that falls on it. If it were not for reflection we should see nothing except the source which gives off its own light.

You are sure to have noticed that a ball thrown at right angles to a smooth surface bounces right back at you. If, however, you throw the ball at an angle to the surface it bounces off at the same angle, but in the opposite direction. Light reflects off surfaces in the same way.

When you brush your hair before a mirror, rays of light reflected from your face bounce against the mirror and are turned back along the same path by which they came. Move to one side of the mirror. In your new position you cannot see your reflection. A friend standing on the other side of the

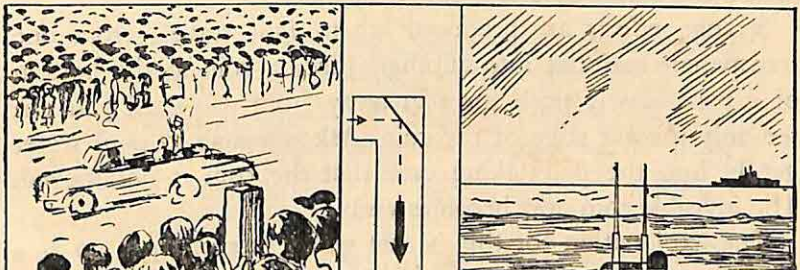
Reflection

mirror can see your reflection just as you can see hers. Like the bouncing ball the light that is reflected from your body bounces against the mirror and then into your friend's eyes. In bouncing from you to her and back again light makes equal angles with the mirror.

Perhaps you have teased someone by reflecting the light of the sun into his eyes with the help of a small mirror. For complete success the mirror must be held in such a way that the light from the source makes the same angle with the mirror as the reflected beam which is sent into the eyes of your victim.

Every motor-car and motor-bus is fitted with a small mirror. The driver uses this mirror to watch the traffic behind him.

The captain of a submarine is able to look over the water with the aid of a Periscope. You can make a periscope from two



1. *Peeping over the heads of a crowd with a periscope.* 2. *The inside of a periscope.* 3. *Using the periscope in a submarine.*

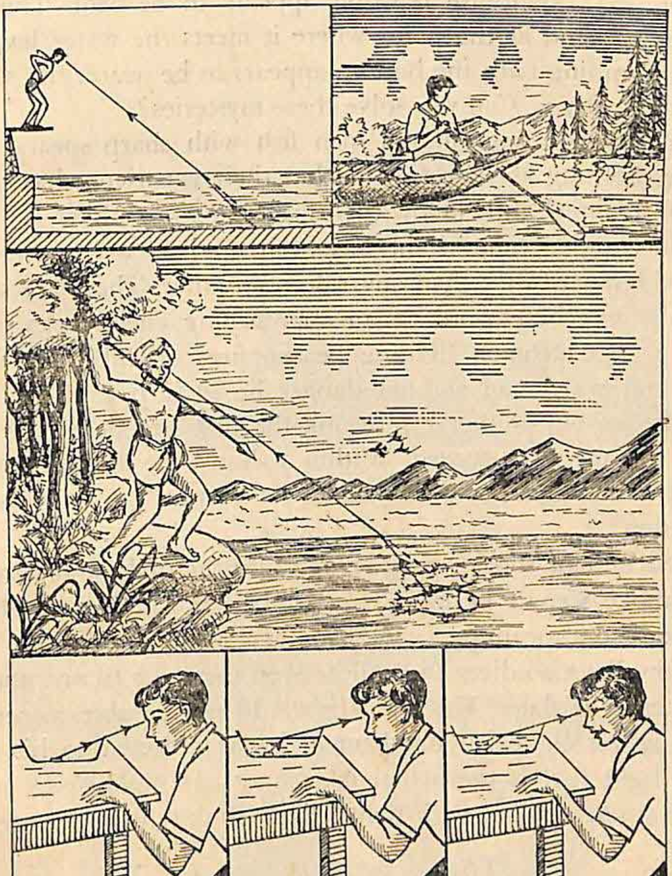
mirrors of equal size and a few strips of cardboard. Each mirror is fitted into the cardboard tube at an angle of 45 degrees. Your periscope will come in very handy for peeping over the heads of a crowd.

When light strikes a surface it reflects off that surface or passes right through it. A material which allows us to see through it is said to be transparent. Many useful articles are made of glass because it is transparent. There are yet other kinds of material that allow some light to pass through, but not enough to let us see clearly through them. These materials are called translucent. When rays of light fall on frosted glass they become twisted and broken and mixed. For this reason we see some of the light which passes through but not enough to make out what is on the other side. Anything that completely blocks the path of light is called opaque.

Strange effects are produced when light travels from one transparent material into another. Place a coin at the bottom of a pan. Slowly push the pan away from you until you can see only the far edge of the coin. Ask someone to pour water gently into the pan taking care that the coin is not moved. The invisible coin now becomes visible.

The explanation for this is that when rays of light go at a slant from air into water or from water into air they do not go along the same path but are bent instead. This bending of light is called refraction. At first the side of the pan keeps the light from the coin from entering your eyes. Water in the pan bends the light from the coin at the surface making the coin visible. You do not see the coin where it really is as it now appears to be higher up in the pan. It seems to be in a straight line with your eye and the edge of the pan.

You have probably noticed that a stick lying partly in the



Refraction

1. The floor of a swimming bath appears nearer than it actually is. 2. The paddle appears bent. 3. Spearing a fish. 4. The coin and pan experiment.

water, in a slantwise position appears to be bent. The stick seems to bend at the point where it meets the water level. At the swimming bath the bottom appears to be nearer the surface than it really is. Can you solve these mysteries?

In some of our villages men fish with sharp spears. They know nothing about refraction but their experience has taught them to aim slightly below their target to score a hit.

Since olden times light has been used as a messenger. It travels much faster than any rider or runner. There are stories in history where word of an approaching enemy was passed along by watchmen lighting beacon fires on hill-tops. When the first watchman sighted danger he lit a pile of wood. A watchman on another hill seeing the first fire lit his own. In this way the news spread. Within a short time the town would receive the signal and commence its preparation to resist the invasion.

Red Indians shot flaming arrows into the night and also sent up smoke signals by day. The number of arrows or puffs of smoke had a meaning.

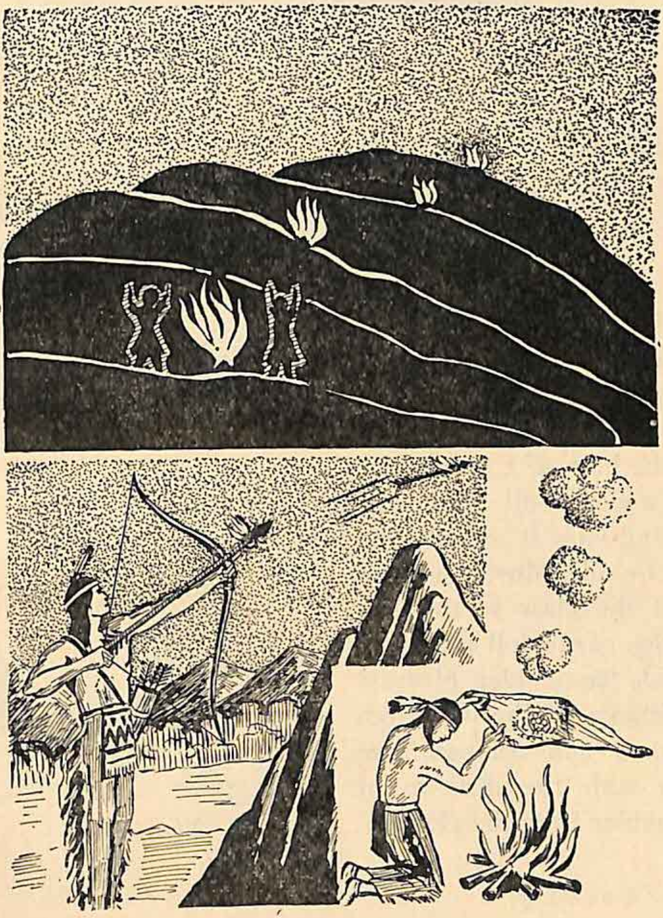
Nowadays, soldiers and sailors send messages to one another by means of flags. The watcher would not be able to see the flags unless light fell on them and was reflected to his eyes. It is light that is the actual messenger. At night ships at sea blink at one another with lights. Each blink tells a message.

Things to make and do

For your wall newspaper:

The shapes and sizes of shadows depend on the fact that light travels in straight lines. Draw a picture showing a source of light on the left, an opaque object in the middle and the shadow which results on the right. Rule in the rays of light.

1 2 3



Using light as a messenger

1. *Beacon fires.* 2. *Flaming arrows.* 3. *Smoke signals.*

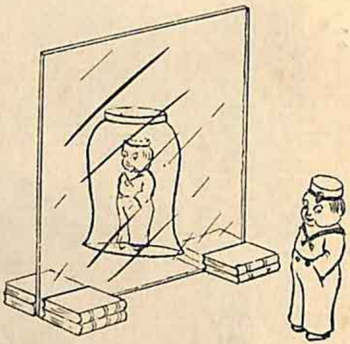
From examples seen around you:

Make lists of:

(*a*) Animals that are blind; (*b*) Animals that can see well in dim light;
(*c*) Natural sources of light; (*d*) Artificial sources of light;
(*e*) Good reflecting surfaces; (*f*) Transparent substances;
(*g*) Translucent substances; (*h*) Ways of using light as a messenger.

The prisoner in the cage of glass:

You must have observed that the further away you move from a mirror the further behind the mirror does your reflection seem to be. Support a sheet of glass in an upright position with the help of a few books. Place a little doll before the glass and look at its reflection from one side. Move a tumbler behind the glass so that the reflection of the doll appears to be inside the tumbler. Measure the distance of the doll from the glass and compare this length with the distance of the tumbler from the glass.



The prisoner

In your note-book:

Correct these sentences:

1. We can shut out light completely by closing our eyes.
2. We are able to see things because our eyes give out light.
3. Cats can see best in total darkness.

4. A sheet of glass with white paper pasted behind it reflects light better than if it had black paper behind it.
5. Tissue paper is transparent.
6. A full-moon is a better source of light than a half-moon.
7. A body placed in water appears deeper than it actually is.
8. A hurricane-lamp gives out two beams of light.
9. A stick held upright in a pond appears bent.
10. For an object to cast a shadow it must be opaque.

6

Sound Fun

BE AS quiet as you can and listen. You will hear so many different kinds of sounds. They may be made by people, animals or machines. There are other sounds which nature makes in winds and waters: noisy, frightening ones, like those heard in a thunderstorm; and soft, pleasant ones like the babbling of a brook.

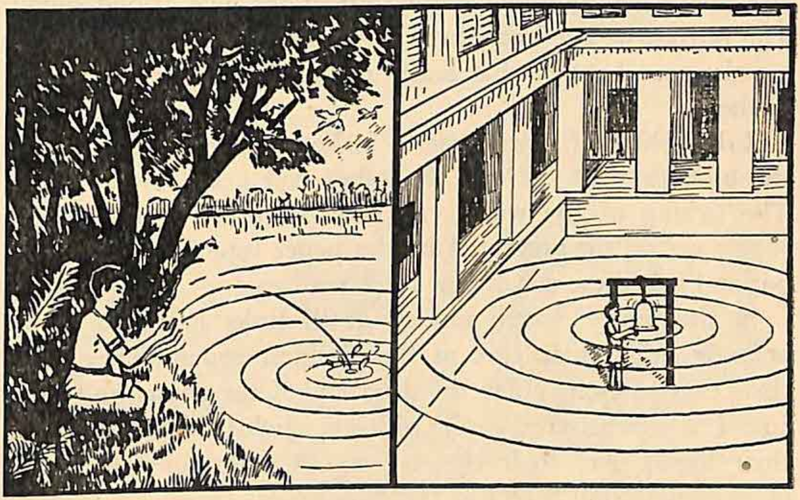
Let us consider for a moment a few common sounds. We are all familiar with the buzz of a bee, the rustle of paper, the whirr of a lawn-mower, the rattle of a cart and the tinkle of glass. All these sounds have something in common between them. They are all caused by movement. Yet many movements do not produce any sound at all. You can walk on tip-toe without distrubing anybody, or move your arms about quite noiselessly. We shall soon see that sound is only produced by a certain kind of movement.

Stick a blade into the crack of a table. Bend it back and let it go. The blade moves back and forth very quickly and in doing so makes a sound. All sounds are caused by some sudden motion or by a rapid to-and-fro movement which we call vibration.

When the school bell is rung the metal begins to vibrate very quickly. The movement in these vibrations is of such a short distance that you cannot actually see it at all. Sound a bell and then touch the metal immediately. You can feel the

vibrations. Your touch, however, stops the vibrations and stops the sound too.

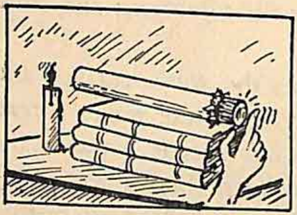
A stone thrown into a tank disturbs the water surface and little waves form in ever-widening circles. These waves spread out in all directions and travel at equal speeds towards the bank. Near the centre, where the movement began, we notice that the waves are strongest. As each wave advances farther away from the middle it becomes weaker. Sound travels through the air in very much the same way.



Water waves *Sound waves*

The moment something vibrates the air around it is disturbed and begins to vibrate as well. These vibrations, which spread out through the air as rings of motion, are very like waves on water and are called sound waves.

Make a tube out of cardboard. Tie a thin sheet of balloon-rubber over one end. Place the tube on a few books and bring



The flickering flame

its end in line with the flame of a candle. A tap will make the rubber sheet vibrate. The vibrations of the rubber sheet cause the air in the tube to vibrate. As the vibrating air 'taps' the flame, it begins to flicker.

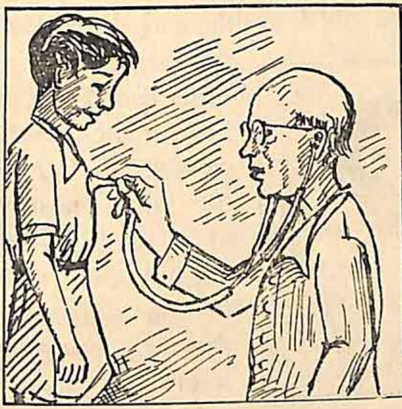
When sound vibrations reach our ears they 'tap' our ear-drums and make them vibrate. We then hear the sound. Strong vibrations give a loud sound. The farther we are away from the source of sound the weaker are the sound waves that reach us and the fainter the sounds we hear.

Roll a sheet of newspaper to make a tube. Put one end of the tube to your ear and the other end near a wrist-watch. The ticking of the watch can now be heard. A few of the sound waves are prevented by the paper tube from spreading out and it is these waves that reach your ear.

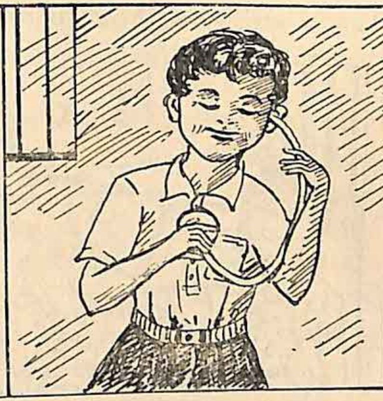
In the jungle where sudden death lurks in the shadows, animals prick their ears at the slightest sound. They move their ears so as to judge the direction of the sound and catch sound waves better. People who are slightly deaf either cup their hands over their ears or use an ear-trumpet to gather in as many sound waves as possible.

Doctors use a listening tube called a stethoscope to hear our hearts beating and our lungs breathing. The best way to find out how a stethoscope works is to make your own. Insert a funnel at one end of a rubber tube and put the other end to your ear. Move the funnel over your heart and listen to it beating.

Although the sounds that reach us are conducted through



A Stethoscope



Make your own stethoscope

the air to our ears, solids and liquids will conduct sounds as well. In fact, sound travels more quickly and easily through most solids and liquids than it does through air.

Stories are told of how a Red Indian brave used to press his ear to the earth to hear the galloping approach of far-distant horses. In this way he was able to hear the sound of hoof-beats long before they reached him through the air.

Listening for hoof-beats

Place a wrist-watch on one end of the table and press your ear against the other end. You can hear it tick quite clearly. Yet from the same distance away you would not hear the watch if you relied on the air to bring its sound to you.

Sending sound through a stick

Here is an amusing experiment which shows you how well sound travels through solids. Bite one end of a stick and ask a friend to listen in at the other end. Tap your head with a ruler. Your friend will smile as she hears the sound. The sound travels through the bones in your head and reaches her ears by way of the stick. The remarkable part of this experiment is that anyone standing near you may not hear the sound of the tap but the listener hears it distinctly.

Water, too, allows sound to go through it very well. The next time you visit the swimming pool, duck your head under water and bang two stones together below the surface. The noise is so loud that it is almost deafening.

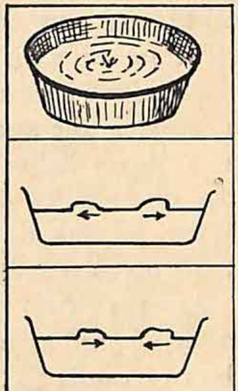
But the most striking experiment of all is that done near a water-pipe. Press your ear to the pipe while a friend taps a distant part of it with a stone. You are likely to hear three distinct sounds: one coming through the metal, another through the water and a third through the air.

A really good thunderstorm is one of Nature's marvels. Flashes of lightning and crashes of thunder make the heavens

appear as a great battlefield. The dark, mysterious clouds seem to be at war with one another over our heads and rain pours down drenching everything. Towards the end the clouds move away to a distant part of the sky and we can watch the thunder-storm continuing from afar. We now have the opportunity of learning another interesting lesson about sound. You will notice that lightning is seen before a clap of thunder is heard. The reason for this is that light travels faster than sound.

Sound travels roughly at the rate of one mile in five seconds. By counting the seconds between lightning and thunder you can easily tell how far away a thunder-storm is. In the case of forked lighting the spark is very long and takes a zig-zag path across the sky. We hear the crashing sound of thunder at frequent intervals from different points along the fork; and so our ears receive a lengthening, rumbling sound when the lightning has passed. A short bolt of lightning, or lightning which takes place over our heads, gives only one clap of thunder.

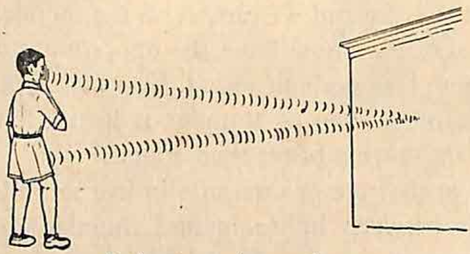
If you watch a game of cricket from afar, you will see the bat hit the ball a little before you hear the knock. So also if you watch a gun being fired from a mile or so away you notice that there are a few seconds between seeing the puff of smoke and hearing the sound of the shot. These two examples are further instances of the fact that light travels faster than sound. Can you name any others?



Reflection of water waves

Fill a pan with water and start a small wave at the centre. See how the wave moves to the edge, piles up against the sides and ripples back to the centre without

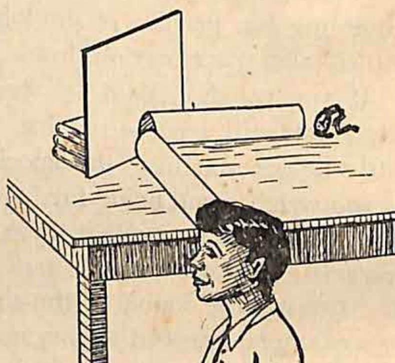
losing any speed. A stronger wave will repeat the movement many times. Sound waves are reflected like these water waves. The reflection of sound is usually spoken of as an echo. Anything that stops a sound wave and sends it back again will make an echo. Large, smooth surfaces such as a wall or cliff give very good echoes. To get the best results you must stand far away from the wall so as to give time for the sound you send out to return again to you.



Reflection of sound waves

Remembering that sound travels at about 1,000 ft. in a second an echo is useful for calculating how far away a reflecting surface is from you.

Sound can be steered round a corner in the same manner as a mirror helps to change the direction of light rays. What mirrors do to light, walls do to sound.



How to make sound go round a corner

Arrange two cardboard tubes against a smooth stiff sheet of cardboard. Place a wrist-watch at the far end of the tube and listen at the end of the second tube. You will hear the ticking of the watch. Repeat the experiment covering the

cardboard with rough cloth and again by removing the cardboard strip.

In a small room that is closed in from all sides echoes will rebound many times. They come back too soon for us to hear them separately, and instead mingle with the sound first sent out. The two sounds together add up to give double the amount of loudness. This is the reason why your voice sounds so much louder when you sing in the bathroom compared with a song in the other rooms.

Similarly when you speak into a bucket your voice sounds louder than if you were to call into a flat pan. Surfaces that are curved-in reflect sounds better than those that are flat.

Using a megaphone

When you cheer your team to victory on the games-field why do you sometimes cup your hands around your mouth? Megaphones, or speaking trumpets, serve the same purpose, but they help to direct sound better. This instrument reflects the speaker's voice and more sound reaches the place where it is required.

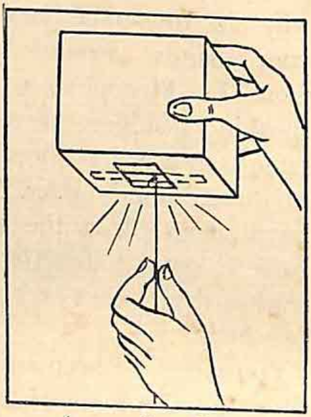
You have just been reading how sound can be made louder. There are also ways of hushing sounds. Lay a ruler on a table with part of it jutting over the edge. Hold it down firmly with your left hand and start the other end vibrating with your right hand. Compare this sound with the sound made when a cushion is placed between the ruler and the table. The


Hushing sound

cushion has the effect of hushing the vibrations. Most of the vibrations enter into the cushion and the cushion absorbs the sound.

Churches, concert halls, cinemas and assembly halls are constructed so that there is a curved recess behind the speaker. This arrangement helps to reflect the voice of the speaker forward and send the sound waves into the hall. To prevent echoes producing an irritating effect, curtains or some other sound-absorbing material are used to cover the reflecting surfaces that echo back the speaker's voice.

You can reproduce the roar of a tiger, the bark of a dog or the shrill cry of a bird if you can manage to find the right-sized box. Cut a hole in one side of a cardboard box. Tie the end of a string to a small stick and put this end into the cardboard box. Rub resin on the string. Pull the string and hear the sound which comes from the box. Because of the resin on the string your hand moves with a number of short, fast jerks. Each jerk sets the stick vibrating which in turn vibrates the box. A small box will vibrate very rapidly and give a high note. A larger box will vibrate less rapidly and give a low note. The


A sounding box

same is true of bottles, forks, drums and other things: little sings high, and big sings low.

You can actually see the vibrations in the case of a stringed musical instrument. The thickest string gives the lowest note, that which gives the highest note is very thin. Before playing his instrument a musician may tighten and loosen the strings to get the note he desires. He knows that a tighter string gives a higher note. So also he may move his fingers along the strings while he plays and thus alter the length of the strings. A long string gives a lower note but a short string gives a higher note. Notes, therefore, depend upon the size, length, thickness and tightness of an object.

Take two empty milk bottles of different sizes. Tap each one and listen to its tone. Pour water into the large bottle and keep tapping it until you match its tone with that of the small bottle. You will find that the amount of water in a bottle effects its tone. This experiment can be done in another way.

Stiffen your upper lip and gently blow across and slightly

Two ways of making air vibrate

down the top of an empty bottle. To make a higher note pour some water into the bottle. Vary the experiment still further by inserting a glass tube into the water. As you raise or lower the tube you change the height of the column of air. Depending on the length of the column of air which is set vibrating by your breath, the note changes from low to high or from high to low. When playing a wind instrument the musician lengthens or shortens the column of air to make the notes on the scale. From anna-whistles to expensive trombones, sound is produced by the vibration of air within them.

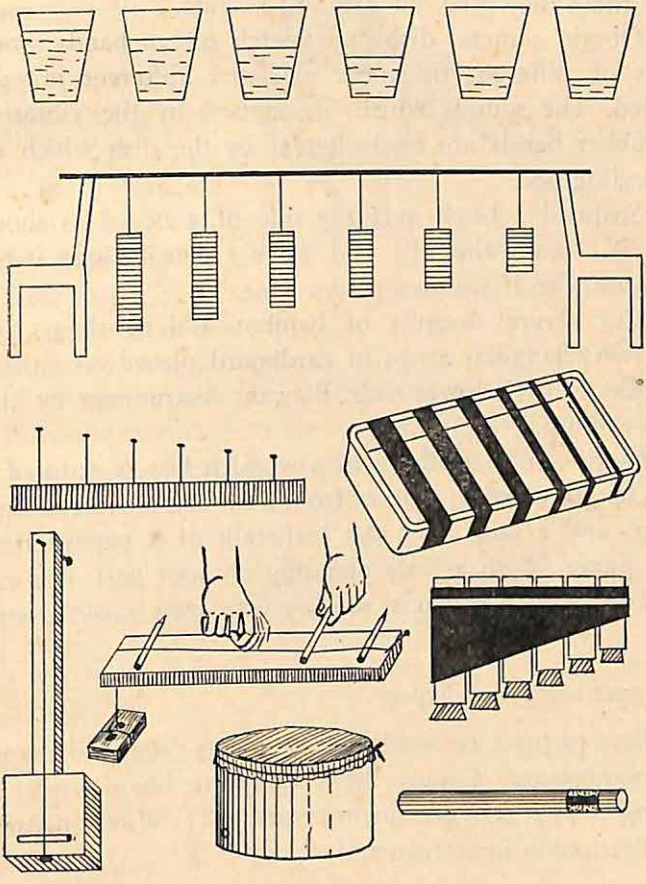
Sound has many uses which are known to us in everyday life. The song of a bird, the whisper of the wind, the soft gurgle of a waterfall, and the sound of beautiful music add pleasure to our lives. There are other sounds — noises, which though unpleasant to hear, have their uses. The honk of a motor-car, the bang of a gun, the crash of crockery, and the screech of an owl have a meaning. Sometimes the noise about us becomes so unbearable that we try to get away from it. We may succeed, but it is almost impossible to escape from sound.

Things to make and do

Home-made music:

1. Collect a few tumblers and tune them by pouring water into them up to different levels. Put the low-sounding tumblers on the left and the high-sounding tumblers on the right. Try to play a simple tune by tapping them gently.

2. Saw a stick into several parts, each part slightly smaller than the other. Hang them to a cross-stick that is laid over two chairs. Gently tap the sticks near their middles and try to play a tune.



Home-made musical instruments

3. Hammer pins into a board to different depths. When you pluck them they give out pleasant sounds.

4. Obtain a metal dish and stretch rubber bands around it. Bands of different thickness will give different notes when plucked. The sounds which are caused by the vibrations of the rubber bands are made louder by the dish which acts as a sounding box.

5. Suspend a brick over the side of a board as shown on page 63. Twang the wire and move a pencil along it to vary its length. See if you can play a tune.

6. Cut several lengths of bamboo and tie them together with two triangular strips of cardboard placed on either side. Fit corks to their lower ends. Play the instruments by blowing down the top.

A banjo can be made from a wooden box, a strip of wood and a length of wire; a drum from a tin and a sheet of balloon-rubber; and a flute from the leaf-stalk of a papaya tree and tissue paper. With a little planning on your part, you can get your friends to join you in starting your own music group.

For your wall newspaper:

Collect pictures of musical instruments from old magazines and newspapers. Group them on your board under these headings: (1) Stringed instruments. (2) Wind instruments. (3) Percussion instruments.

In your note-book:

Write a summary of this chapter, listing the main ideas about sound.

Across the fields:

Make your own telephone

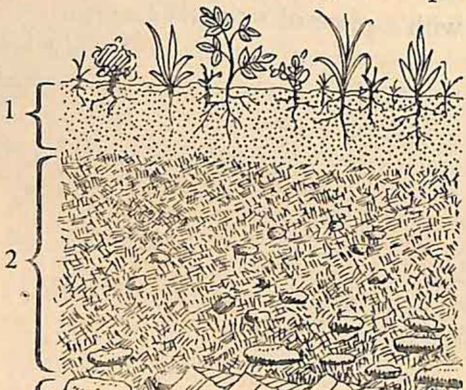
Two cigarette tins and a length of string will help you to set up your own telephone. Punch a tiny hole through the centre of the bottom of each can. Pass the ends of the string through the holes in the two tins and tie knots to prevent the string from slipping out. Have a friend take one phone and ask him to move away until the string is tight. If you wish to attach the connecting line to any object, tie the line to the object with a piece of string.

7

The Soil and Us

WHEN we think of the countless creatures that inhabit the earth we begin to realise the importance of plants on which all animals depend for food. The plant in its turn relies on the salts in the soil for its nourishment. Besides being a source of food, the soil means something more to the plant; for it gives the plant support and supplies it with water.

If there is a road cutting, a deep trench or a quarry near your home, visit it and see the different layers of soil. The uppermost layer is usually black or dark-brown in colour and is known as the topsoil. The layer which is more tightly packed is called the subsoil. This layer is lighter in colour, and may contain stones, but unlike the soil above has fewer plant roots. Beneath the subsoil is a layer of rock. There are different kinds of topsoil.



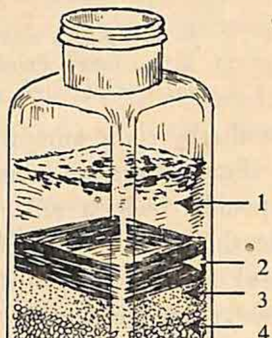
A road cutting
1. *Topsoil.* 2. *Subsoil.* 3. *Rock.*

The soil in one part of the country is often different from that found in another part of the country. Even on neighbouring farms we may notice a difference.

One way in which soils differ is in the size of their particles. Accordingly, the soil is divided into three main groups: sand, silt and clay. Sand particles are large enough to be seen clearly, silt particles are smaller and clay particles are too small to be seen separately.

When plants and animals die, their bodies decay and sooner or later become part of the soil. This portion of the soil that comes from plant and animal remains is called humus. You must know that when plants are burned ash is formed. The ashes are the salts which the plants took up from the soil while they lived. When plants die these salts are returned again to the earth. It is Nature's plan that nothing goes to waste.

Take a handful of soil and put it in a jam-jar filled with water. Allow the soil to settle in the jar and inspect the contents after a few days. You will observe that the humus floats on the surface while the heavier portion of the soil sinks to the bottom of the jar. This experiment is a good way of finding out whether the soil in your garden has more clay or sand in it.



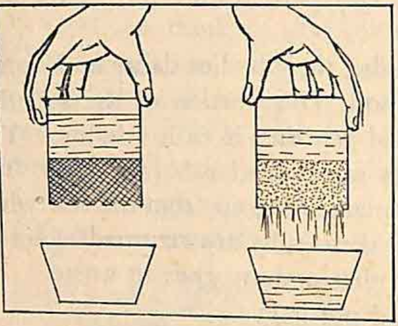
After the soil has settled

1. *Humus*. 2. *Clay*. 3. *Sand*. 4. *Gravel*.

In your experiment you must have noticed that the water became muddy when the soil was added. It was the clay in the soil that made the water look muddy. Separate the clay from the mixture by pouring off the water very

gently. Now feel the clay between your fingers. It feels slippery. Sand, however, feels rough.

Here is an experiment which will teach you something else about sand and clay. Take two cigarette tins and punch a number of holes in the bottoms. Half-fill one tin with dry sand and the other with dry powdered clay. Place two tumblers of the same size and shape beneath the tins. Into each tin pour equal amounts of water. Note the time taken by the water to trickle through these two kinds of soil.



Water passes easily through sand (right) but not through clay (left)

As the life of the plant depends very largely on the water present in the soil, good crops can be produced only from a soil that can supply the plant with the right amount of water to satisfy its needs.

Sandy soils are loose and allow water to drain through them quickly. Such a soil soon becomes dry and plants that grow in them suffer from insufficient water. On the other hand a soil can have too much water in it for plants. Clay soils hold water and the spaces between their particles become filled with water. Now, the roots of plants must have air. If water fills up all the spaces in the soil, then the roots will die due to lack of air. After a shower of rain a soil consisting mostly for clay becomes very wet. This is because water drains away very slowly with the result that puddles are formed.

Farmers and gardeners find it very difficult to work in a

clay soil. In the monsoon this soil is difficult to plough or dig, for it is slippery and heavy. In the hot weather it becomes hard and cracks as it dries and shrinks. Sandy soils, however, are easy to work.

Most plants will not grow in a soil made up of clay alone or on a soil consisting of pure sand. There must be humus present in the soil. A soil made up of sand, clay and humus is called a loam. A sandy soil to which humus is added holds more water. The addition of humus also improves a clayey soil. Humus pushes the soil particles apart and yet keeps them loosely bound together.

A loamy soil retains water and yet allows drainage. Air enters and fills the spaces between the larger particles. Farmers and gardeners like to work such a soil for it has plenty of plant food, is easy to dig and does not become too dry or too wet. Loam is by far the best soil for plant growth.

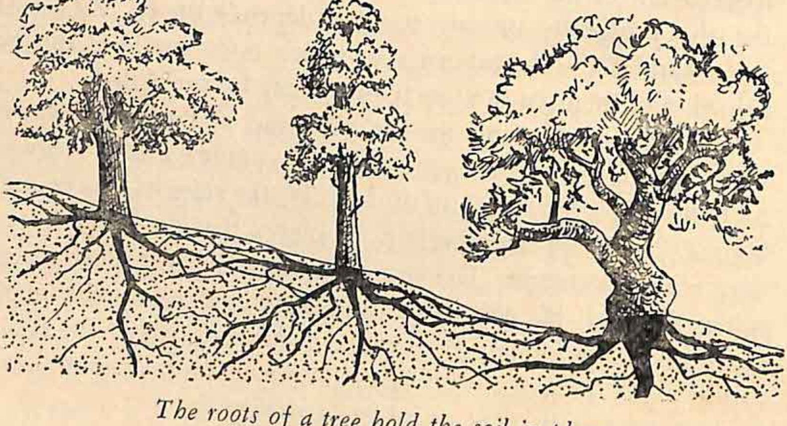
Year by year, unless suitable steps are taken, our soil becomes poorer. Barren land cannot produce crops to feed us or grass to feed our cattle. It is very important that our soil be saved, for the prosperity of our country depends on it. We must understand the different ways in which our farm-land can be ruined, and then see how such waste may be prevented.

Chief among the soil thieves are wind and running water. Dust storms carry fine particles many miles away. Heavier particles pile up in the form of drifts on the sides of fences, and houses. This happens especially in places that are not covered over with vegetation. The top soil removed by a dust storm ruins the land. By destroying forests and removing the grass from fields, land is laid bare and unprotected against the force of the wind. To guard against such an evil the land must have its own natural blanket of plants covering it.

Rain water that flows over the land may not sink into the ground and may instead form a ditch. At first a ditch may be small. As water continues running down its slopes it becomes wider and deeper and longer. Branches forming at the sides soon make a network of furrows over a field, thus destroying it.

After a particularly heavy shower a field is sometimes covered over with a sheet of water. As water flows off the field it carries away part of the topsoil. When this damage has been repeated many times, the soil in the field has more stones in it and may be of a different colour. In places where the rains are heavy and there is an absence of plant cover, good fields are spoiled by the action of running water. In the garden the effect of running water is clearly seen. The topsoil from a flower bed is often washed away after heavy rains, but the topsoil of the lawn escapes damage. Good soil carried away by running water is taken by streams to the river which finally carries it to the sea.

To protect the soil from the wasteful effects of running



The roots of a tree hold the soil in place

water, the land must be covered with plants that have spreading roots, such as rapidly growing grasses, which help to hold the soil in place. Water that runs off a field should be made to flow through protected channels. The sloping sides of ditches should be planted to prevent them becoming wider. In the case of a field that slopes, drains should be made so that they run across the field rather than downwards. The addition of humus helps greatly for it makes a sponge-like surface on the ground and soaks up the rain water which otherwise may run off.

Once wind and water have ruined a field it takes many years to make that field fertile again. Floods and dust-storms are responsible for crop failures because of the rich topsoil they remove, and this leads to food shortage.

Fertile farmland, if not managed wisely, will in time become barren. During its lifetime a crop absorbs certain salts from the field. When the crop is harvested the plants are removed. If this is done year after year the soil becomes poorer. So a fresh supply of salts must be added to suit the needs of the new crop. The wise farmer spreads manure on his field. Often he adds fertilizers to replace the salts that were removed by the previous crop. The addition of these substances keeps his soil fertile and gives him a rich, abundant harvest.

Things to make and do

Visit the countryside:

1. Collect samples of gravel, sand, clay, loam and humus.

2. Find loams that are (*a*) especially clayey, (*b*) especially sandy.

3. Test the soil from (*a*) under trees, (*b*) a lawn, (*c*) a garden bed, (*d*) a ploughed field, (*e*) the side of a stream,

(*f*) the mud bank of a pond, (*g*) barren land. The test can be carried out by putting a handful of soil from each one of these places into separate tumblers of water. Measure the amounts of sand, clay and humus present in the different tumblers. Show by experiment which soils hold the most water.

For your wall newspaper:

Illustrate this chapter by taking photographs of:

1. The side of a quarry;
2. Cracks in clayey soil;
3. Land which has suffered from the effect of wind and running water;
4. A barren hill-side;
5. A hill-side covered over with forest;
6. A field covered with a sheet of water;
7. A plant protected ditch;
8. A ditch with no vegetation on its sides;
9. A field with hardly any humus on it;
10. A farmer ploughing his fields;
11. Harvesting the crop;
12. A fertile field.

In your note-book:

Explain the following:

1. The soil is sometimes spoken of as 'Mother Earth'.
2. The story of the soil is one of life, death and wealth.
3. Trees are both soil-makers and soil-savers.

See for yourself:

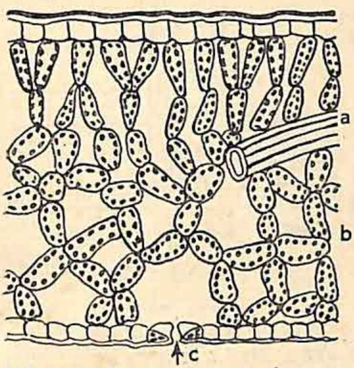
Obtain five flower-pots. Fill the first with topsoil, the second with soil taken from about one foot below the surface of the ground and the third with soil taken from about three feet below the ground. Plant a dozen mustard seeds in each of the pots. Water the pots regularly. Try to account for your results.

8

Factories of a Plant

A VISIT to a factory is an exciting experience. As we enter the gate the commotion we see bewilders us. Workers are busy bustling about, shouting instructions, banging things, and managing noisy machines. After watching for some time, however, we see a meaning in every movement and a purpose for all the activity. Something is being made.

Plants have factories too. Each green leaf is a factory. Here food is made. Only green plants can make food and that is why their factories are considered to be the most important in the world. Plants make not only their own food but also enough food for every other living thing on earth.

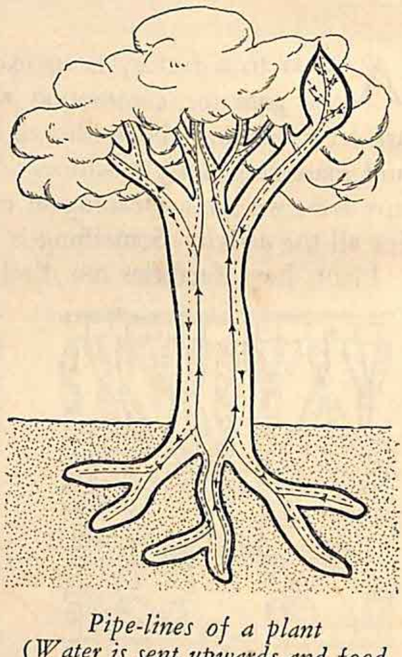


The inside of a plant factory (much enlarged)
(a) pipes (b) cells containing chlorophyll (c) pores

Inside a factory there are many rooms. In certain rooms there are machines. Thousands of rooms called cells make up a plant. The cells are so small that our eyes cannot see them. The picture on this page shows how cells in the leaf look when

they are enlarged. You will notice that some cells have small, round bodies in them. There is a wonderful green substance, called chlorophyll, in each of the bodies. These tiny green bodies are the machines of the plant.

It is interesting to compare a shoe factory with a plant factory. In the shoe factory the machines are run by electricity, and shoes are manufactured from leather and thread. In the plant-factory the machines are run by sunlight, and starch is manufactured from carbon dioxide and water. The waste of a shoe factory consisting of bits of leather and thread can be seen lying on the floor. In the case of a plant the waste cannot be seen as it is oxygen.



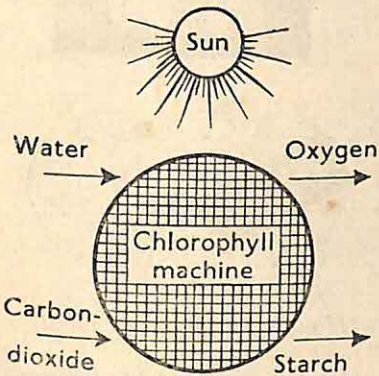
Pipe-lines of a plant
(Water is sent upwards and food is sent downwards)

The roads leading to a factory are used to bring in materials needed at the factory. The plant factory has one of its materials sent to it along pipes. Water taken in by the roots is sent up the pipes in the stem to the leaf where it is used to make starch. The second material, carbon dioxide, is found in the air and enters in through the tiny pores of the leaf.

Every factory has store rooms where the manufactured articles

are stored. The starch made in the leaf by day, is taken away along pipes to places where it is required, or to cells where it is stored. Food-pipes and water-pipes lie side by side along the full length of the plant. Storage cells are to be found in the centre of the stem and root. Some plants very wisely store their food in special underground stems such as bulbs, tubers and rhizomes. The roots of the carrot and turnip swell because of the food stored in them.

How does the plant make food from such common substances as carbon dioxide and water? Nobody knows. Scientists have sought the answer to this question for hundreds of years, but the plant has kept its secret well. If you mixed a jar of water with a jar of carbon dioxide and kept it out in the sunlight, you would certainly not obtain starch. It is only the green machines in the plant that can bring about the change. And think what a wonderful change it is! From a colourless liquid and a colourless gas, a white solid is made. Silently and with no commotion at all, the plant factories continue their important work of producing the food supply of the world.



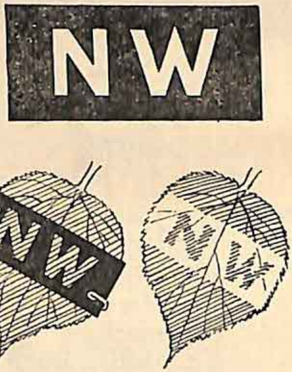
What a chlorophyll machine can do

Experiment in your kitchen at home and prove for yourself the facts about plant factories of which you have just been reading.

Since starch is the final product in a plant factory, you must

commence your experiments knowing the test for starch. A potato may be called a plant-warehouse for it contains a large number of tiny rooms filled with starch. Slice a potato and add a few drops of iodine on to the cut side. The colour of the potato changes to blue-black.

Leaves can be tested for starch once the green colour is removed from them. Pluck a few green leaves which are growing in a sunny position for your experiment. Boil the leaves in water for a few minutes so as to kill them. Follow this by soaking the dead leaves in methylated spirit. This removes the chlorophyll. Wash the leaves in water and then put them in iodine solution. Notice what happens.



How to print your initials on a leaf
Above: a piece of black paper with initials cut out.
Left: the black paper pinned to the leaf.
Right: after the leaf has been tested for starch.

For the next experiment you must ask someone to collect a few green leaves during the early morning, before there is any light. The leaves collected should be kept in a closed box until you are ready to experiment with them. Test the leaves for starch, and note if they become blue-black.

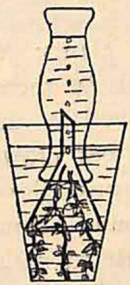
Now for a surprise! This experiment will show you how to 'print' your initials on a leaf. Fold a piece of black paper once and cut your initials through both layers. Enclose the leaf of a plant growing in the sunlight between the layers and clip it into position with paper fasteners. Do this in the late evening.

Pluck the leaf on the following afternoon and test for starch. Can you explain your result?

Leaves make starch only during the daylight hours. At night the starch is moved to wherever it is needed and the surplus starch is taken to the store rooms. Every morning the plant starts the day with starch-free leaves.

Suppose you were one morning to break the connection of a leaf with the plant by plucking it. Next you kept it alive by putting its stalk in a saucer of water and placed it in the sunlight so as to give it a chance to make starch. Then later on in the day you shut the leaf in a dark cupboard for several hours. Thereafter you tested the leaf for starch. What do you think your test would show? Try it and see. Your result will give you an idea of what would happen in a factory if it continued producing goods and there was no demand from the customers, nor any store rooms available in which to stock the goods.

In the garden you may see leaves of many colours: red, yellow, purple and green. There are leaves of two colours and some even have three colours mixed together. Such leaves are called variegated leaves. As you have read it is only green leaves that contain chlorophyll. Is chlorophyll needed for starch formation? Experiment with a two colour (green and yellow) leaf and find out.



Oxygen leaving the plant factories

That plant factories give off a gas during starch formation can be proved in the following way. Place some green submerged water-plants in a bowl filled with water. Add a pinch of baking soda to the water. Some of the carbon dioxide produced dissolves in water and is used by the plant for starch manufacture. When the bubbling ceases,

trap the water-plants under the mouth of a funnel. Invert over the funnel a bottle filled with water, taking care that air does not accidentally bubble into the bottle and spoil your experiment. Place the apparatus on a stool in the sunlight. Bubbles of gas will be given out from the plant and will collect in the bottle. Test the gas with a glowing splinter and see if it is oxygen. Satisfy yourself by repeating the experiment with the apparatus placed in the dark. Is there a difference?

Oxygen leaves the starch factory through the same pores by which air containing carbon dioxide enters. The pores are present only on the lower surface of the leaf. In this position the tiny openings are safe from being blocked by rain and dirt, and gases can pass in and out.

Finally we must see whether leaves will make starch if carbon dioxide is prevented from entering the pores. To do this keep a potted plant in darkness for a day. Smear the lower side of a leaf with vaseline and expose the plant to sunlight. After several hours test the leaf for starch. Make sure that the result you arrive at is correct by testing one of the other leaves of the plant as well.

It seems strange to think of competition among plants; yet the struggle for light is a matter of life or death to them. Without light the chlorophyll machines are powerless and cannot make food. In the jungle where huge trees crowd closely together, the spreading foliage of their crowns allows hardly any light to pass through and reach the ground below. Their tiny relatives, the herbs, find it very difficult to make enough food with the light they receive. The little plants soon become a sickly yellowish colour and perish.

But the climbing plants know a way of overcoming the difficulty. They twine their stems around a tree's trunk and

pull themselves upwards by holding on to twigs or clinging to branches with their roots. Then up and up they go, climbing to the light. On reaching the topmost branches they spread themselves over the tree-tops and arrange their leaves in the sunshine to their best advantage. You need not go into the jungle to see this competition. At this very moment it is happening in your own backyard. Throughout the story of nature you will read how many living things, both plants and animals, have certain methods of their own by which they save themselves from the dangers of life.

A climber on its way to the light

Things to make and do

Outdoors:

1. Notice how plants arrange their leaves so that each one may have its fair share of light.

2. Look at the pattern made by the leaf shadows of a tree on the ground below. What does the pattern show?

3. Search for plants whose leaves are deeply cut into points. Do such shapes help the plant to get light?

4. Make a list of the climbing plants you see during your hikes. Sketch the parts which help the plant to climb.

For your wall newspaper:

Do a simple outline sketch of the plants growing in a wood near your home.

In your note-book:

How would you prove the following:

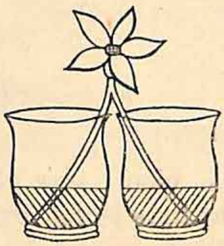
1. Bread contains starch. 2. A plant cannot make starch in electric light. 3. Chlorophyll can be made only in sunlight. 4. The leaves of a potted plant turn and face the light.

Write an account of the experiments you perform. Illustrate each experiment with a coloured drawing. Arrange your work under headings such as these:

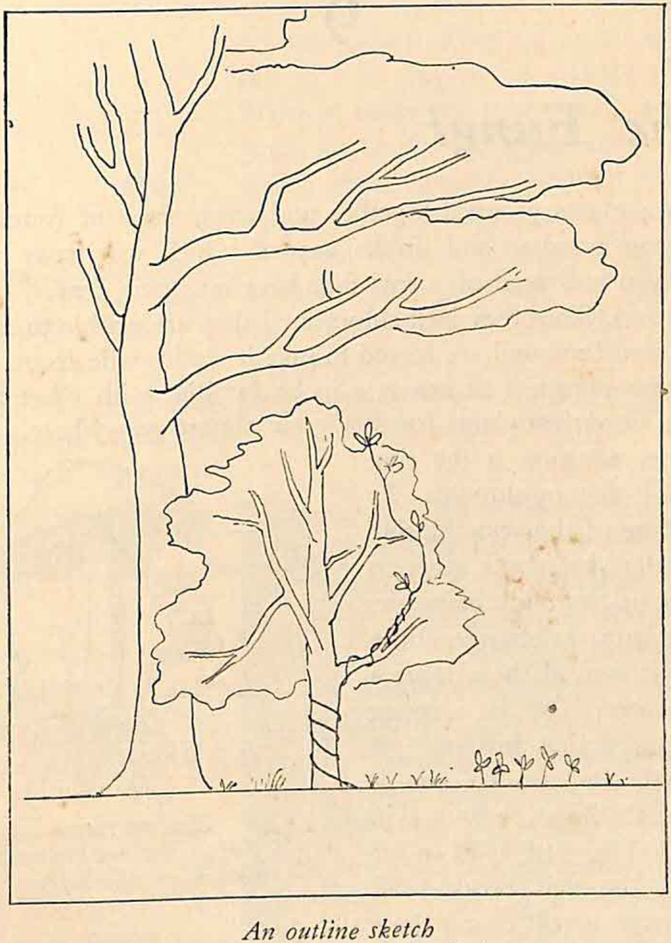
REQUIRED TO SHOW THINGS REQUIRED METHOD OBSERVATION CONCLUSION

Improving on nature:

Find a plant bearing white flowers. Split the flower stalk up the middle with a blade. Place one half in a tumbler containing red ink and the other half in a tumbler containing blue ink. The pipes in the flower stalk will take the ink up to the petals and give you a two-coloured flower.



Improving on nature



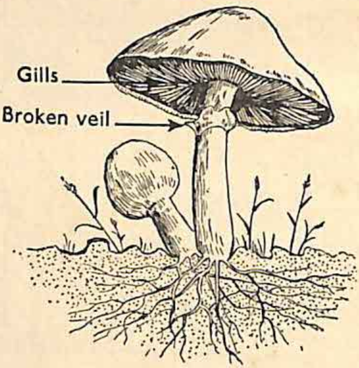
An outline sketch
to show the struggle for light

9

The Fungi

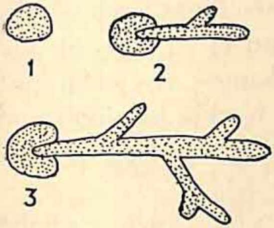
THE plants grouped together under the name of fungi are most peculiar and unlike any of which you have read. Here you will read of plants that have no stems, leaves, roots or flowers. Since they lack chlorophyll they are unable to make their own food and are forced to take it ready-made from dead or living things. You are sure to be familiar with these non-green, flowerless plants for they grow almost everywhere.

The monsoon is the time to look for mushrooms. At this time of the year the tiny umbrella-like plants seem to spring up overnight by magic. Sometimes a strange little knob is seen at the side of a mushroom. This is a young mushroom that has not yet opened. Its swollen top is joined to the stalk by a skin called the veil. When it opens, the veil breaks and remains as a frill round the stalk.



Mushrooms
(A half-grown mushroom is shown on the left)

Under the caps of some mushrooms are a number of plate-like partitions called gills. Under the caps of others are fleshy surfaces full of pores. In between the folds or inside the pores



How a thread grows out from a spore (much enlarged)

numerous spores are formed. The spores correspond to the seeds of a green flowering plant. They are as fine as dust and fly with the wind to distant places. When a spore comes down to earth it sends out a slender white thread that slowly worms its way through the soil seeking the decaying remains of plants on which it feeds. The thread branches repeatedly and spreads out in all directions. Throughout the year the tangled threads remain in the soil. Under favourable conditions some of the threads mass together in a little knob which pushes its way above the ground and opens into the familiar mushroom shape.

A mushroom is simply an arrangement for making spores. It is sent above ground by the great underground fungus network so as to be in a favourable position to disperse its spores by the wind. Nobody can guess where the fungus threads lie until a mushroom pops up.

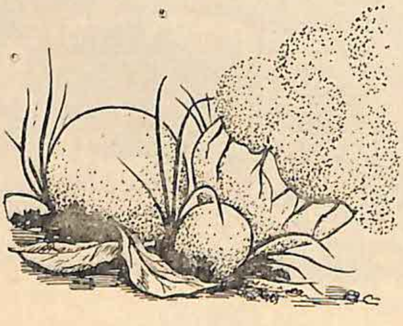
A fairy ring
Inset: the first few mushrooms

Mushrooms grow in damp, dark surroundings such as the foot of a tree, in the corner of a shed and in all sorts of odd places. They appear with startling suddenness and then just as suddenly wither away. The caps now tumble to pieces and only dark masses, like blots of ink are left to mark the spots where they once grew.

If you are lucky, you may see a fairy ring growing on the lawn. The mushrooms that form it start out in a central cluster and as the food in the soil gets less the threads grow away from the centre, searching for food. It is for this reason that the ring continues to increase in size.

Puff-balls are closely related to mushrooms and found in wet shady places or in grassy fields. Their curious rounded shapes lead us at first to suppose that they are a number of eggs lying on the ground.

A puff-ball feels leathery to the touch and is milk-white in colour. Its inside is spoken of as 'the meat', and is made up of threads and spores. If you squeeze a ripe one between your thumb and forefinger it will burst, giving out a powdery cloud of minute spores. Each of these spores can grow into a new plant.



Puff-balls

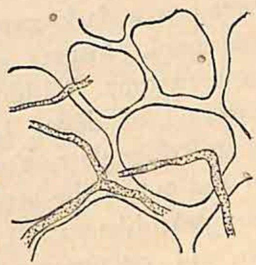
Have you ever seen a tree which is decorated with a number of shelves growing in tiers all the way up the trunk? These jutting outgrowths are the bracket fungi and their appearance means that the doom of the tree is sealed.

Some of the bracket fungi live on dead wood, but many feed on the living tree. The latter kind suck out the life-juices of the plant on which they grow, making it weak and sickly, and often killing it outright. They are like uninvited guests who arrive suddenly and eat the food of their host without offering anything in return. The plant that suffers is called the host and the plant that lives at the expense of its hard-working neighbour is called the parasite.

Bracket fungi

How do the bracket fungi manage to enter the host-plant? Well, it is the wind that brings their spores to the trunk of a tree. If the spores find an injured place in the bark, threads are sent out which enter the wound and go into the heart of the wood. Now the work of destruction begins. The threads grow sideways, upwards, and downwards, taking nourishment from the tree as they grow. This gradually weakens the tree.

Once established the straggling threads seek a wound in the bark through which they may push out and make a bracket. In this part of the fungus, spores develop and, when ripe, drift through the air to other trees where the damage is likely to be repeated.

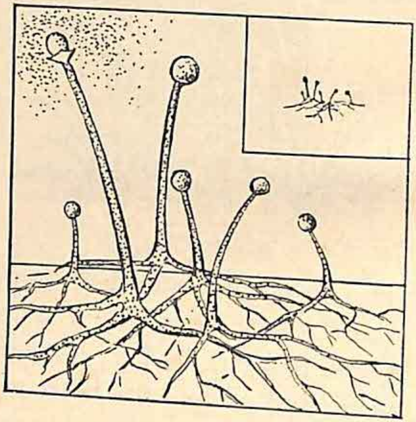


How cells are attacked by a fungus (much enlarged)

On some of the bracket fungi you will see half-rings which tell you how old they are. These kinds build a new layer of cells every year. If the tree heals its wounds the fungus is imprisoned and cannot push out a bracket.

When we see a diseased tree we say it is rotting. It may be the bracket fungi that are responsible for making the wood worthless. A tree that is attacked by fungi has no strength to withstand the force of the wind and is blown over in a storm.

Among the commonest members of the fungi family are the Moulds. In wet weather they are found covering almost anything, from old shoes to stale bread. The conditions they need to thrive in are dampness and darkness. Their spores are present in the air and, if conditions are right, start a growth the moment they settle.



A growth of mould
Inset: actual size of a mould

Place a piece of moist bread in a dark corner of a cupboard. Inspect it from time to time. Within a few days mould will appear like a covering of down. Look at the mould through a powerful magnifying glass. You will see a forest of threads weaving in and out of the bread. Soon the mould becomes dotted with tiny pearl-like spore cases. A case is as small as the head of a pin and contains an immense number of spores. As the head ripens it becomes black and finally bursts delivering its contents to the wind.

The majority of the fungi are the villains of the plant world. Many bracket fungi are the deadly enemies of trees. Certain other kinds of fungi, such as rusts, blights and smuts ruin our grain and food crops. The farmer wages a never-ending battle against these pests, protecting his plants by spraying and dusting them with chemicals. Fungi attack men and animals as well. You will be surprised to know that ringworm is caused by a fungus and so also is the mange on a dog. Water is no barrier to a fungus spore and many a goldfish in an aquarium suffers an attack. Caterpillars, house-flies, wasps and water-beetles all fall victim to the parasitic fungi.

Not all the fungi, however, are bad. Some of them play an important and useful purpose in the plan of life. A few of the bracket fungi live on the stumps of dead trees and feed on the remaining food material until the stump crumbles and becomes part of the soil. They thus hasten decay and prevent our forests from becoming choked by dead plants. There is a large number of other fungi that feed on plant and animal rubbish causing decay to take place more quickly.

A single-celled fungus called yeast is used to make bread rice. In Europe cheese-makers add fungus moulds to cheese to give it a delicious flavour.

Scientists have discovered how to make use of a certain kind of fungus to destroy insects that harm valuable plants. Some of these insects are first captured and treated with the fungus. They are then set free and allowed to join their companions. When they mix with their fellows the fungus disease spreads. In the course of time a good number of the insects die of the disease.

Recently it was discovered that a substance called penicillin can be obtained from a mould. This discovery brought new hope

for the suffering. Today penicillin is used by doctors all over the world and has saved countless from dying of horrible diseases.

Things to make and do

In the fields and woods:

1. Look for mushrooms and bracket fungi.
2. Note (*a*) where they are found; (*b*) on what they are growing; (*c*) the number of individuals in a particular spot; (*d*) the colour under the cap; (*e*) whether the underside has pores or plates; (*f*) if the colour changes as they grow old; (*g*) how long they live.
3. Draw and colour fungi growing in their natural surroundings.
4. Gently pull away the spore-making part and see the food-getting part.

For your wall newspaper:

Take a freshly opened mushroom and slice off the cap. Set the cap, gills downward, on paper that has been previously smeared with the white of an egg. Leave it like this for a day in a dark place. Then lift the cap and examine the paper. The tiny specks on the paper are spores. Together with each spore-print you make, do a drawing of the mushroom and mount them side by side.

In your note-book:

Compare a mushroom with a rose plant. Say how they are different and how they are alike.

Catch spores:

Spores of the fungi are everywhere, riding on the wind. Try to catch some and grow them. This is what you do. Place some cheese, leather, jam and bread in separate saucers. Keep them in a warm dark place. Moisten the pieces of bread, leather and cheese regularly. Within a few days different kinds of moulds should make their appearance. Record the number of hours they take to form pin-heads. Then lay these fungus growths in the sunshine and see what results.

Are there spores present in dust? Gather some dust on the tip of a feather and sprinkle it on a bit of bread. Moisten the bread and cover it over with a tumbler. Let it remain for a while in the dark. From the dust a fungus garden will grow.

10

Plant Thieves and Cannibals

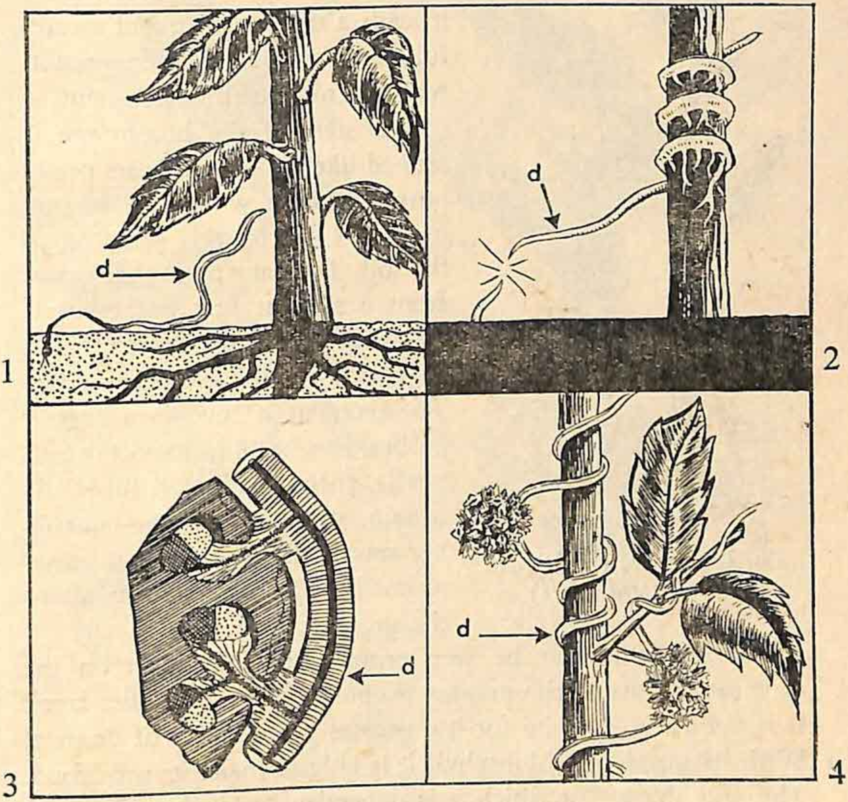
A FEW of the flowering plants are handicapped from the day they are born by an absence of chlorophyll in their leaves and stems. Consequently they are forced to rely on their more fortunate neighbours for their food supply. This is the story of the lives they lead and the way in which they overcome their difficulties.

The Dodder is occasionally seen growing in hedgerows or on the tops of wayside trees. In appearance it resembles a mass of golden threads and looks very decorative. The plant bears no leaves and since it has no chlorophyll is forced to steal its food.

In the monsoon, white waxy flowers appear in clusters along the stem. Gradually the flowers change to fruits which drop the seeds in them on to the earth. The seeds sprout and the young dodder stem sways in the breeze, reaching out towards its nearest leafy neighbour. As it makes contact it winds its long straggling stem round the host plant, driving in suckers which penetrate the food tubes of its victim, and sucks out some of the food for its own use. Once established the dodder is settled for life and breaks the connection with its seed. If the seedling cannot find a host, it dies.

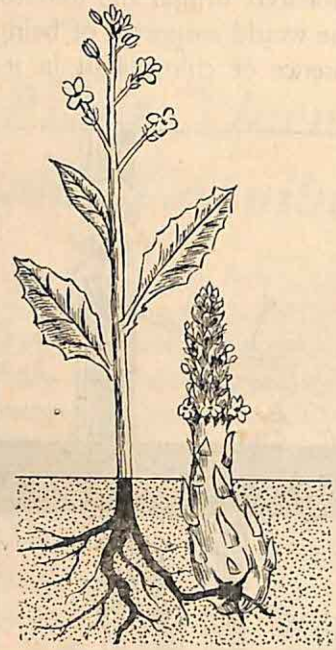
Another parasitic plant is the Broomrape. You will usually

see it growing in fields of mustard, tobacco, brinjal and tomato. It seems quite respectable and no one would suspect it of being a thief, but it is. The complete absence of chlorophyll in its



Picture-story of the Dodder (d)

1. The seedling nears its victim. 2. The young plant twines around its victim. 3. How the dodder sucks its food. 4. The dodder in flower.

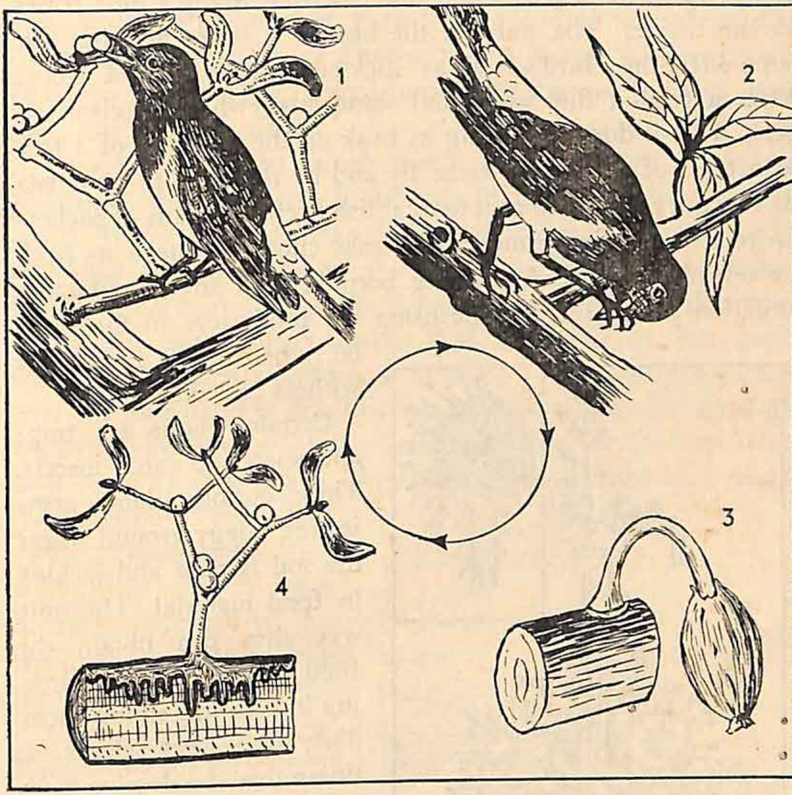


The Broomrape (*right*) *and the Mustard* (*left*)

stem and scale-like leaves betrays its secret. You will see no evidence of its thieving habits above the soil. Beneath the ground, however, it leads a different life and a careful search will reveal its connection with the roots of the host plant.

The stem of the broomrape is shaped like a club and bears pretty purple flowers which, on becoming fruits, scatter tiny seeds on to the soil. The baby plant that grows from a seed at first pushes itself downwards, and slowly revolves in its search for the root of a plant. The moment it touches a root it pushes a sucker into its victim and swells, forming a small tuber. As it gains strength from the nourishing sap of the host plant it grows upwards and pushes its way above the ground.

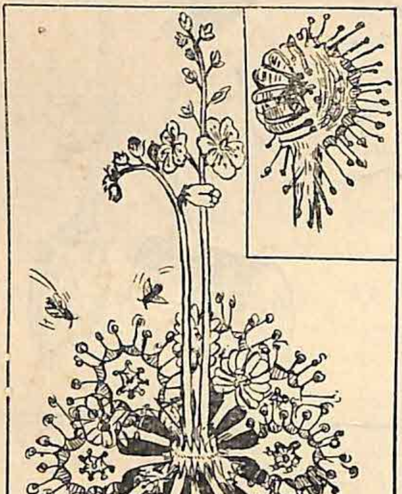
The Mistletoe may be seen growing perched aloft on the topmost boughs of the mango, peepul, banyan and other trees. It is not a true parasite for it possesses green leaves of its own. With its supply of chlorophyll it is able to make its own food. The only things for which it is dependent on its host are salts and water, substances which normal plants get from the soil. To obtain these materials it sends rootlets up and down the branch of its host and at intervals drives 'sinkers' into those tubes of the tree that carry salts and water.



Picture-story of the Mistletoe

1. *A bird eating the fruits of the mistletoe.* 2. *The same bird scraping off the seeds.* 3. *A mistletoe seedling.* 4. *How the mistletoe sucks its supply of water from the host plant.*

In the proper season the tiny green flowers of the mistletoe change to white, almost translucent berries. Many a bird feasts on the berries. The pulp in the berries is sticky and has the same effect on a bird's beak as 'stick-jaw' on the jaws of a boy. After a feed it flies away and settles somewhere to clean its beak. This it does by wiping its beak on the branches of a tree to get rid of the sticky seeds. By and by the baby plant bursts its way out of the seed-coat to establish itself by means of suckers on to its host. Sometimes a bird may choose to clean its beak on telegraph wires. A seedling born in such an unfavourable situation grows for a while using the food store in the seed; but when this is finished it withers and dies.



The Sundew
Inset: a fly caught by a leaf

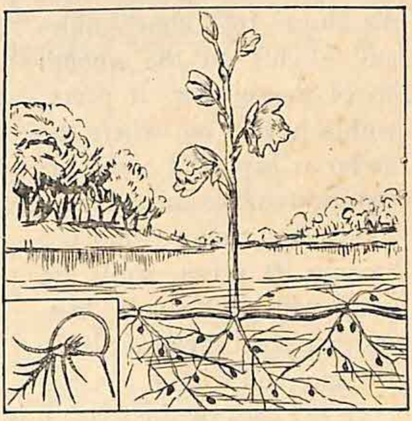
Certain plants set traps and snares to catch insects. These curious plants grow in wet, boggy ground where the soil is poor and lacking in food material. The only way they can obtain the food they need is by catching insects and eating them. They are very clever at doing this and deceive many an unsuspecting insect.

The Sundew is one of these plant ogres and to see it you must visit marshy land. During the summer pretty pink flowers are borne on a stalk which arises

from the centre of the plant. The red leaves are spoon-shaped and lie flat on the ground. Each leaf is covered with numerous hairs called tentacles, that have at their tips tiny gummy drops. It is the glistening of these drops, like dew in the sun, that gives the plant its name.

An insect mistaking the shiny drops on the plant for nectar alights on the leaf for a drink only to find itself in a deadly snare. Tentacles bend down on it from all sides like so many clutching fingers, covering it completely. Though the insect struggles hard to free itself, it cannot escape and will never spread its gauzy wings again. It is held fast by the cruel tentacles and finally suffocates to death. Now the plant proceeds to suck its prey dry. In time only the empty skin remains which is blown away by the first gust of wind. The tentacles then stand erect like pins on a pin-cushion waiting and ready for the next victim.

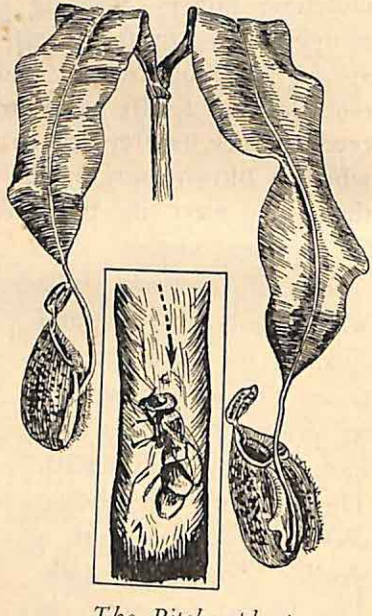
The Bladderwort is a water-plant that is found floating on many of our tanks. You will know it by its yellow flowers, which look like tiny snapdragons. The flowers are borne above the surface on a slender flowering stalk. The leaves are green in colour and broken up into a number of hair-like parts. Some of the hairs have been changed into Bladders. A bladder is the



The Bladderwort
Inset: a bladder

trap which the plant uses to catch and devour wee water-folk that enter in, never to leave again. Each bladder has a trap-door fitted to it. The stiff bristles present near the door are useful for keeping off creatures that are too large to be caught. When a tiny insect touches any of these bristles the trap-door opens immediately. The insect enters and then gets a most unpleasant shock for the trap-door closes behind it making it a prisoner. Inside the bladder it is killed and its juices are absorbed.

Among the most interesting of these insect-eating plants is the Pitcher-plant of Ceylon. The leaf of the plant is partly changed into a hollow pitcher with a lid. An insect is attracted to the pitcher by the gay colours on the lid. It mistakes these markings for honey-guides and alights on the smooth rim of the pitcher. It peers within to find out where the nectar is kept and losing its footing tumbles to its doom. The insect cannot climb out because its prison walls are lined with stiff smoth bristles that point downwards. It struggles and tries to rise but is pricked back by the sharp bristles that face it. Slowly it slips and slides towards the fluid that partly fills the hollow pitcher. Here it meets the same fate as the mass of struggling insects



The Pitcher-plant
Inset: a bee in a pitcher

in the dark pool, which were also deceived by the cunning pitcher. The broth made from the drowned insects is absorbed by the leaves to strengthen the plant.

Other countries have parasitic and insect-eating plants as well. Look for books that describe them in the school library. You will be amazed at the lives they lead and the way they play their part in the never-ending battle for life.

Things to make and do

Plan an excursion:

Get a few friends together and go into the countryside to hunt for the plants you have been reading about. If you find a parasite, pull it away from its host and look for the connection between the two plants.

Collect the seeds of the dodder and mistletoe. Try to grow them in a plot of earth.

There is a partial parasite named Loranthus that bears orange-coloured flowers and grows on the branches of the mango tree. Search for it.

For your wall newspaper:

Draw and colour the pictures in this chapter for your board.

In your note-book:

Thieves and cannibals are rare among plants and you will have to go far afield to find them. But when we consider animals we find instances of such behaviour common and taking place every minute of the day. Write an account of the animals in your home that make it their business to steal and kill.

Rear insect-eating plants:

If you manage to find a sundew plant, dig it up carefully and take it home. Grow it in a saucer containing a little water. Touch the tentacles of the plant with the point of a pencil and see what happens. Now offer it a fragment of raw meat and watch the way it feeds. Do not feed the plant too much or it will die of over-eating.

Grow the bladderwort in a jam-jar filled with water. Place a bit of raw meat on the point of a pin and poke it into a bladder. Find out how long the meat takes to disappear.

II

Familiar Wild Flowers

THE plants growing by the wayside delight us with the variety and beauty of their flowers. We pass them every day on our walks and soon learn to recognise them. We cannot help but notice that as the seasons change they have changes too. By following each new change in their lives we begin to know more about them. During a ramble we meet them again, growing in all kinds of places. Now indeed, we regard them as old friends about whom we already know so much.

Each part of the plant has its own work to do. The roots absorb water and salts from the earth. The leaves make food. The stem serves as a pathway for food and water. The flower helps the plant to reproduce its kind. Then, when the seeds form, it is the work of the fruit to scatter them far and wide.

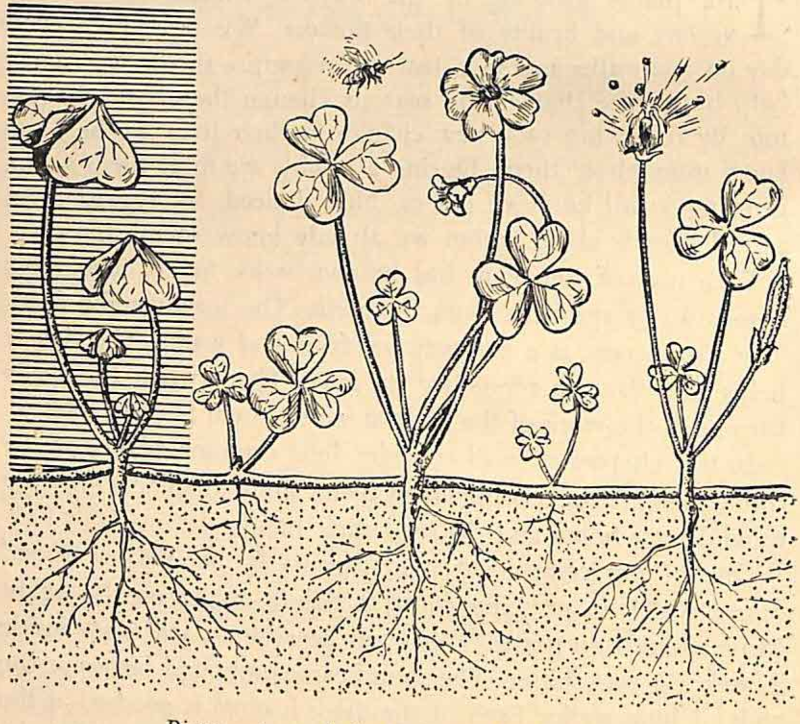
In this chapter we will consider four common plants of the countryside. After reading about them, study the plants growing around your home and discover their habits.

One of our commonest wild flowers is the Yellow Wood Sorrel which in growing forms a dainty carpet on the fields. Most animals do not eat this plant because an acid juice inside it makes it taste bitter. The stem bears compound leaves at the ends of long stalks. Each of the three leaflets is notched at the tip. At night the leaflets close giving the impression that the

plant is asleep. There is, of course, a reason why the plant behaves in this way. By making its leaflets overlap each other it prevents too much water being lost by transpiration.

The Wood Sorrel trails along the ground and sends out stems that creep away in all directions to root and form new plants. This is one way the plant has of reproducing itself; another way is by flowering.

The transference of pollen from the anther to the stigma is called pollination. In this plant the work of pollination is



Picture-story of the Yellow Wood Sorrel
Left: leaf position at night. Centre: pollination. Right: seed dispersal.

done by bees. But the bees do not help the plant for nothing. For their services they are paid in delicious nectar.

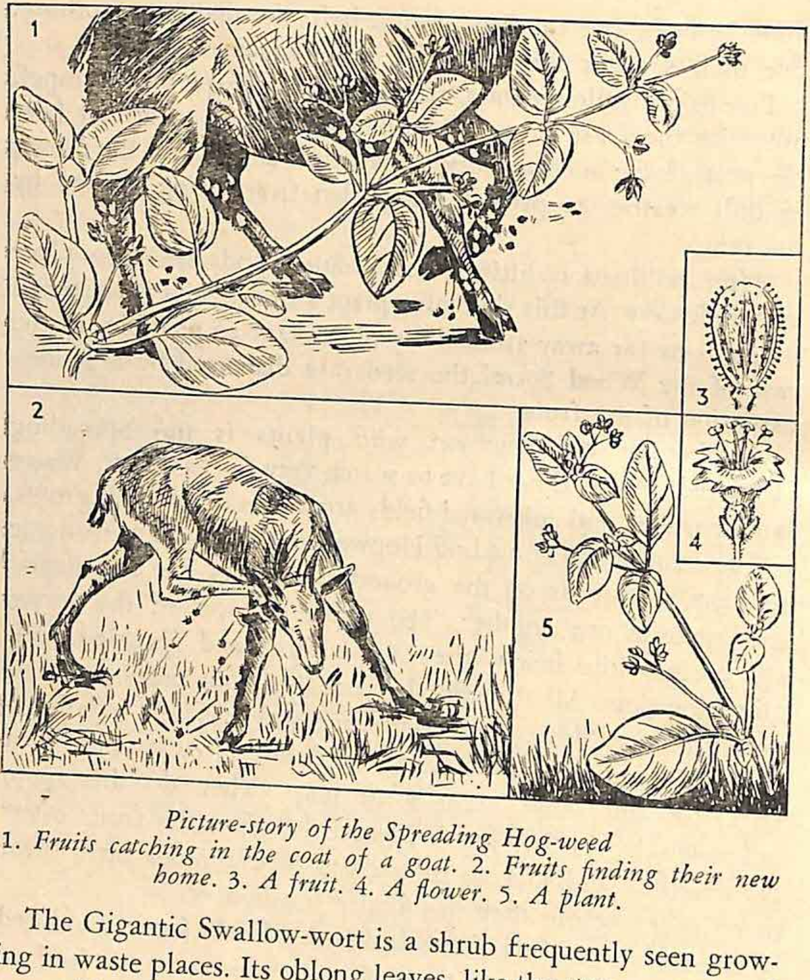
Five bright yellow petals, arranged in the shape of a trumpet, advertise the feast to the bees. Besides serving to attract bees the petals have another duty to perform. They close the flower in dull weather to protect the pollen from being wasted by the rain.

After pollination little, erect, pointed pods take the place of the flowers. At this time of a plant's life its aim is to spread its seeds as far away from the parent plant as possible. In the case of the Wood Sorrel the seeds are dispersed by a sudden explosion of the fruit.

Another of our common wild plants is the Spreading Hogweed. You will not have to search very far to find it. Waste land, pastures and cultivated fields are places in which it grows.

The stem of the Spreading Hogweed is weak and as its name suggests, it spreads on the ground. Its leaves are egg-shaped and opposite one another. The upper surfaces of the leaves are green while below they are whitish and speckled with glistening dots. All through the year the plant bears a succession of tiny red flower-bells. Butterflies and bees help in pollination, changing the flowers to sticky fruits. Now it is the turn of cattle and other animals to help. They do this quite unknowingly. As they brush against the plant the fruits easily get detached and stick to their coats. The animals carry them many miles before they are finally brushed off.

The stickiness of the fruits is due to a kind of gum produced by the hairs which cover them. Cattle that attempt to feed on the plant are troubled by the fruits that stick to their noses and mouths. It is little wonder that grazing animals leave the Spreading Hogweed alone.

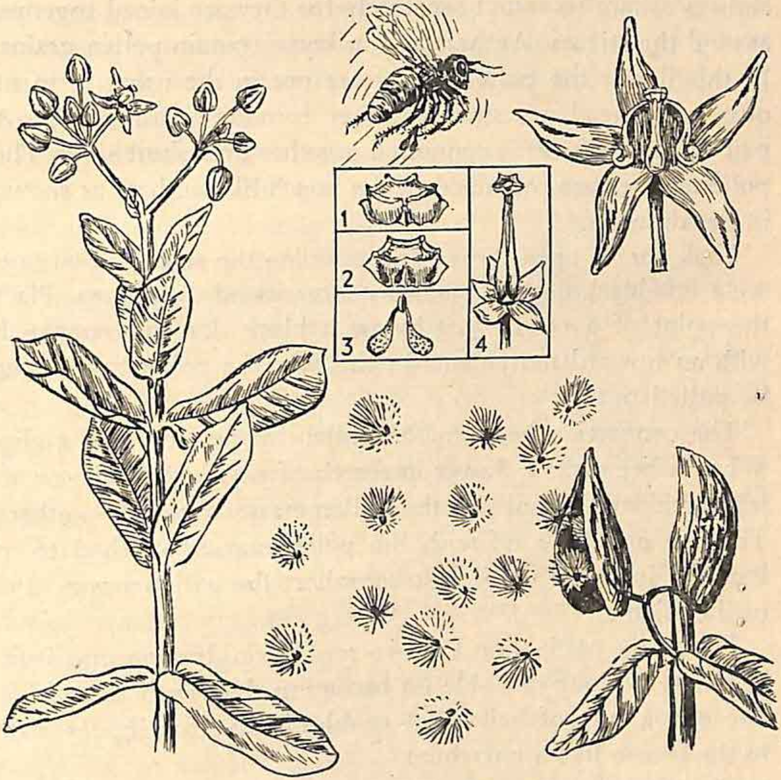


Picture-story of the Spreading Hog-weed
1. *Fruits catching in the coat of a goat.* 2. *Fruits finding their new home.* 3. *A fruit.* 4. *A flower.* 5. *A plant.*

The Gigantic Swallow-wort is a shrub frequently seen growing in waste places. Its oblong leaves, like the stem, are covered over with soft cottony hairs. The opposite arrangement of each pair of leaves helps them to find a place in the sun to make starch. Within the stem and leaves of the plant is a milky juice

that oozes out when a branch is cut. The juice has a sharp taste and an unpleasant smell. On account of this the plant escapes being eaten.

The flowers of the Swallow-wort are purple or white in colour and are shaped like stars. There are five peculiar curved



Picture-story of the Gigantic Swallow-wort
Above: *Bee carrying pollen-masses from flower to flower. Below (right): Seed dispersal. Inset:* 1. *Stigma.* 2. *Anthers opened to show pollen-masses.* 3. *Pollen-masses.* 4. *Pistil with calyx.*

structures in the flower joined together to form a central hollow column. Inside the column are five stamens whose stalks are united together into a tube. The tube contains nectar for the bees. Here too is the pistil, consisting of two separate seed-boxes with their stigmas united together to form one. The anthers cannot be found separately for they are joined together around the stigma. Anthers as you know contain pollen grains. In this flower the pollen grains are not in the usual form of dust but instead are stuck together forming small masses. A pair of these masses is connected together by a short stalk. The pollen-masses are contained in the pouch-like anthers as shown in the drawing.

Look for an open flower and examine the stigma. You will see a few black dots at equal distances round the stigma. Place the point of a needle just below a black dot and remove it with an upward movement. In this way the pollen-masses can be pulled out.

The connection between the pollen masses acts like a clip. When a bee visits a flower in search of nectar the hairs on its legs accidentally pull out the pollen-masses from the anthers. The bee now flies off with the pollen-masses attached to its legs. It flies on to another flower where the pollen-masses stick to the stigma.

Following pollination the two seed-boxes develop into fruits which split along one side on becoming ripe. Each seed has at one end a tuft of hairs that enables it to float lightly away in the breeze like a parachute.

The three plants that have been described show us how seeds may be dispersed by exploding fruits, by animals or by the wind. If the parent plant did not disperse its seeds but merely dropped them beneath itself, the seedlings would suffer

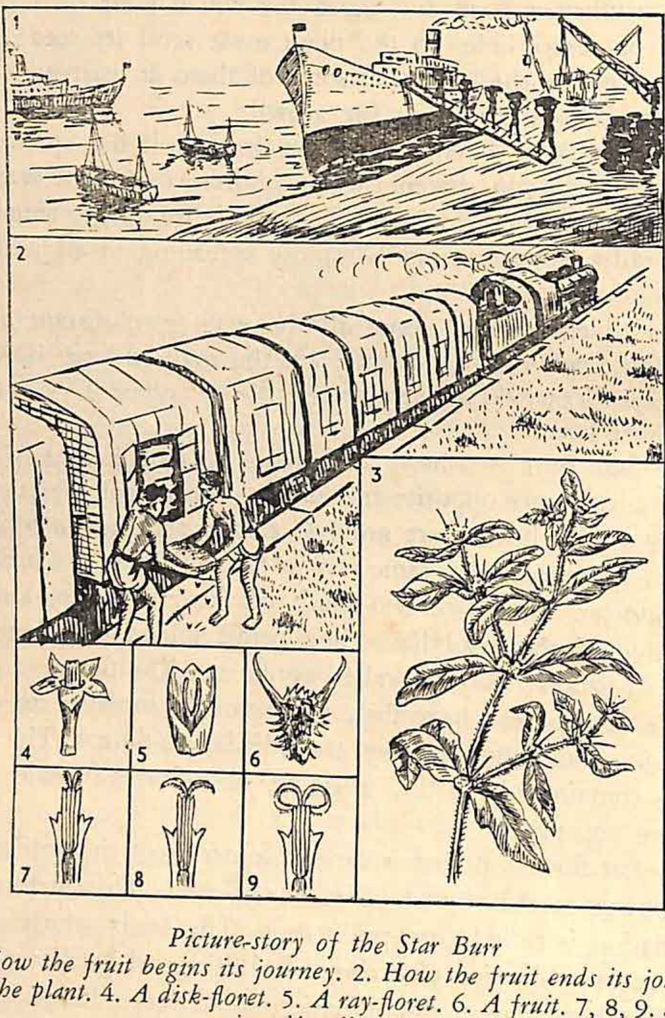
from insufficient food and light, for which their own parent would be responsible. So the plant must send its seeds away on a journey in the hope that some of them at least will meet with favourable conditions for growth.

The Star Burr is remarkable for the way it has spread. At the time when your parents were children, this plant was not to be seen anywhere in India. Today it is found growing near many railway stations and is rapidly spreading to all parts of our country.

This adventurer has come all the way from distant South America. Look for this country on the map and see how far away it is. You will at once realise how wonderful its journey must have been.

The Star Burr is a herb that grows up to a height of two feet. Its leaves are opposite and have no stalks. Soft hairs cover the plant. The flowers are grouped closely together into heads and are arranged in the same way as the flowers in the head of a Sunflower. There are two kinds of flowers. Those around the edge of the head have their petals joined together and look like straps. They are called ray-florets. The flowers in the middle of the head have their petals joined together as well, and look like funnels. They are called disk-florets. The ray-florets contain only pistils, while the disk-florets contain both stamens and pistils.

In most flowers pollen is carried across from the anthers of one flower to the stigma of another flower. This method of pollination is called cross-pollination. The seeds which result from cross-pollination give rise to healthier and hardier plants. On the other hand, cross-pollination is not very reliable. When the Star Burr opens its florets it hopes for cross-pollination. But if this does not happen the disk-florets pollinate themselves.



Picture-story of the Star Burr

1. How the fruit begins its journey. 2. How the fruit ends its journey. 3. The plant. 4. A disk-floret. 5. A ray-floret. 6. A fruit. 7, 8, 9. Stages in self pollination.

The way they do this is very interesting. The pistil found within the tube made by the united anthers, begins to grow in length. As it comes over the top of the anthers the two stigmas curl over and touch the pollen grains. The moment this happens self-pollination is complete.

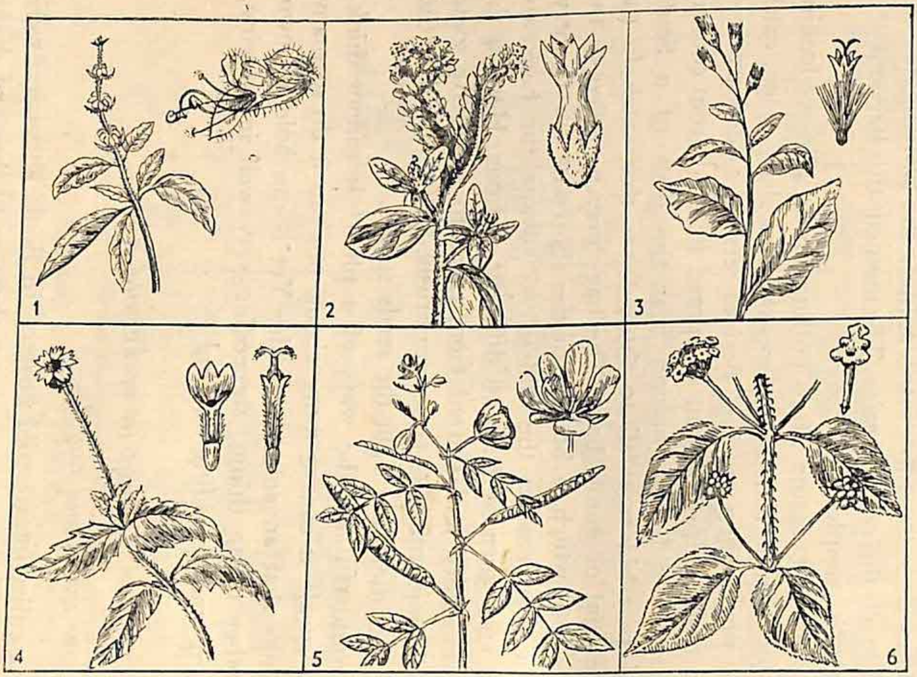
The fruit that forms after pollination is a fierce-looking object. Not wishing to munch a mouthful of sharp spines cattle avoid the plant when grazing. Besides serving as defence weapons the fruits help the plant to spread its kind from country to country. Star Burrs growing near the dock of a South American port bid farewell to those fruits that catch in the rough material of gunny bags. The bags may be taken to the hold of a ship which is bound for the shores of our country. When the ship reaches the end of its voyage the bags are unloaded and taken by train to different stations. Here again they are unloaded and shifted from place to place. At some stage of their journey the fruits are brushed off and fall to the earth. If conditions are right the seeds sprout.

How wonderful are the ways of a plant! It cannot think, it cannot speak, it cannot move about, nor can it do so many other things that an animal can do. Yet it can hold its own among other living things, succeeding very well in growing, multiplying and spreading its kind.

Things to make and do

During your walks and rambles:

Begin a collection of wild flowers. In Book Three you were told how to press plants and mount them on to sheets of drawing paper. The best way of storing them is by keeping the sheets between the covers of a drawing book. Crush camphor



Familiar wild flowers
1. *Hoary Basil.* 2. *Wild Heliotrope.* 3. *Ash-coloured Fleabane.* 4. *Coat Buttons.* 5. *Negro Coffee.* 6. *Wild Sage.*

or mothballs into a powder and sprinkle it over each sheet. This keeps away insects.

In your note-book:

Make your own notes about your favourite wild flowers. Write a brief description of them and their habits.

For your wall newspaper:

Prepare charts showing the life-history of a few wild flowers. Try to make them along the same lines as the drawings in this chapter.

A wild flower garden:

Collect seeds of wild flowers and attempt to grow them in a plot of ground. Plan your wild flower garden carefully and reserve special parts of this garden for different kinds of plants.

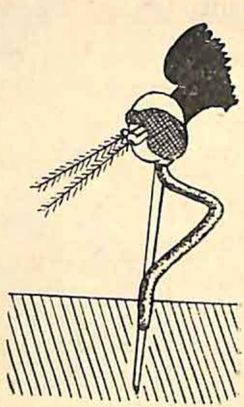
12

Raiders of the Night

WHEN we switch off the light it is the same as ringing a dinner gong for the mosquitoes. These midget dive-bombers come whining out of the night to sip our blood. The curtain of darkness does not hamper their activities for they are able to smell their way to their targets with the help of their feathery feelers.

Few people on earth are safe from being troubled by mosquitoes. From the equator to the poles they pester mankind. Certain kinds are responsible for spreading diseases. So man wages a ceaseless war against them attempting to put an end to their race. But this is by no means an easy thing to do.

Most people believe that mosquitoes feed entirely on human or animal blood. This, however, is not true. Only the female mosquito needs an occasional sip of blood to strengthen her breed. The chief food of mosquitoes is the juice of plants.

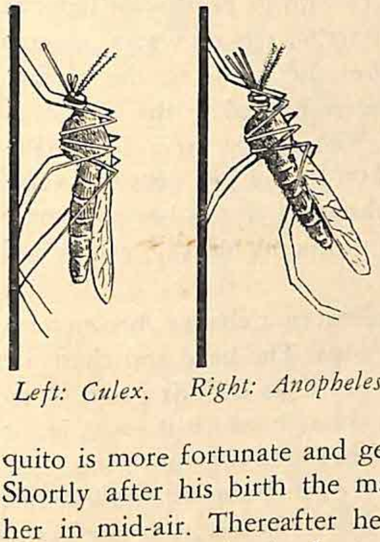


How the female mosquito feeds

Mrs. Mosquito is well equipped for her deadly business. In her snout she

carries her instruments of torture, consisting of needles and drills. Alighting on her victim her first act is to puncture the skin with a hollow needle and inject a certain material to deaden the feeling. Then she begins to feed. If there is any danger of being slapped, she feels the slightest rippling beneath her like an earthquake, and off she goes.

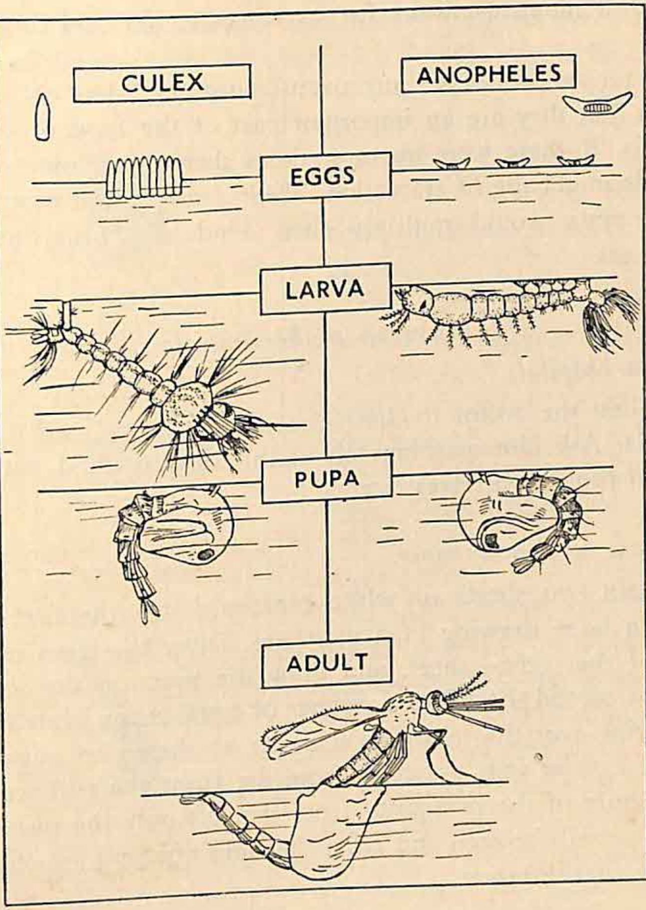
Look at mosquitoes resting against a wall. Some of them called Anopheles stand with their bodies slanting away from the wall. Others called Culex stand with their bodies parallel to the wall. It is the Anopheles mosquito which carries malaria, while the Culex carries filaria and dengue. An Anopheles mosquito that has bitten a person suffering from malaria is capable of passing on the disease to whomsoever she bites next.



Left: Culex. Right: Anopheles

A male mosquito lives for about a week. A female mosquito is more fortunate and generally lives for about a month. Shortly after his birth the male chooses a wife and marries her in mid-air. Thereafter he spends the remaining days of his life flying aimlessly about sipping plant juice.

The mother mosquito lays her eggs on the surface of water. If she is a Culex then her eggs are laid joined together in the form of a raft. An Anopheles mosquito lays her eggs singly, in straight lines, one behind the other. Round each egg is a bag of air which helps it to float. The tiny eggs floating on the water look like a fleet of little boats.



Left: Life-history of the Culex mosquito
Right: Life-history of the Anopheles mosquito

Very soon the eggs hatch and out come hideous-looking larvae. The pictures of a larva show how it looks when it is drawn very large. The head and chest are large and almost round. The body is tapering and has bunches of hairs all along its length. At the rear end of the body is a breathing tube. A larva swims by a series of wriggles, moving along tail first. Every now and then it goes to the top of the water to breathe and feed. On arriving at the surface it twists its head completely round and sweeps the water surface with its brushes of hairs as if it were cleaning a mirror. This action sets up water currents towards it. Minute water creatures that came to the surface seeking light and air find themselves carried to the mouth of the larva by the water currents. The greedy larva feeds continually both on animal food and on tiny bits of decaying vegetation as well. If disturbed it jerks itself to the bottom where it keeps on feeding. As the larva grows, its old skin cracks and is cast off.

After a few days the larva undergoes a change, becoming a comma-shaped creature called a pupa. The head and chest are enlarged in the pupa while the rest of its body is puny. Upon its chest are two breathing tubes through which it sucks in air while resting at the surface. The head has no mouth for a pupa does not eat at all. At the rear end of its body are two leaf-like parts with which it swims. Generally, however, it prefers to stay quite still at the water surface. If touched it sinks to the bottom and then returns again to the surface of the water. The pupa represents the resting stage in the life-history of a mosquito and corresponds to the chrysalis of the butterfly. Inside the pupa a mosquito is formed. When the mosquito is perfect and ready to emerge the pupa skin splits down the back and the insect climbs out. It stands on the empty skin

for a few moments, waits for its wings to dry and then flies away.

Do mosquitoes serve any useful purpose? Men of science tell us that they are an important part of the food of certain animals. If there were no mosquitoes then these insect-eating animals might die of starvation. Their death would mean that worse pests would multiply their kind and bring us unhappiness.

Things to make and do

Visit a hospital:

Request the doctor to show you the medicines used to cure malaria. Ask him questions about this disease. Find out how we can protect ourselves from it.

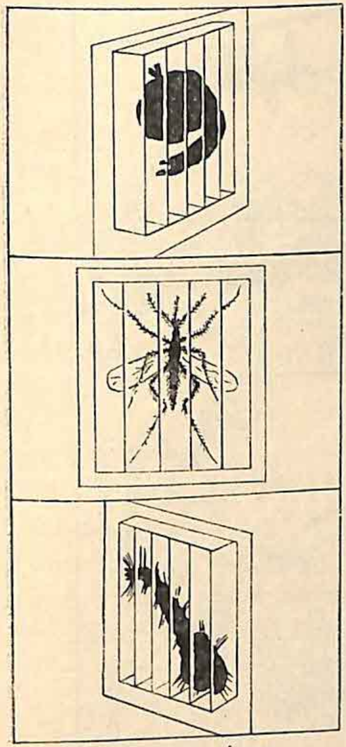
For your wall newspaper:

Obtain two sheets of white cardboard. On the first sheet make a large drawing of a mosquito. Draw the larva on one side of the second sheet, and draw the pupa on the reverse. Cut the second sheet into a number of equal strips. Now mount the strips over the mosquito drawing as shown on page 115. If you look at your drawings from the front you will see only the picture of the mosquito; from the left only the picture of the pupa will be seen and from the right you will see only the picture of the larva.

In your note-book:

Collect mosquito eggs in this way. Place a tumbler containing water in a dark place. Examine the water from time to time. When you see eggs on the surface, take the tumbler

away to a convenient spot and make a study of the life-history of a mosquito. Note the time taken for the egg to hatch, for a larva to change into a pupa and for a pupa to change into a mosquito.



A mosquito frame
Above: as seen from the left
Centre: as seen from in front
Below: as seen from the right

Feed the larvae in your mosquito aquarium on bits of green plants.

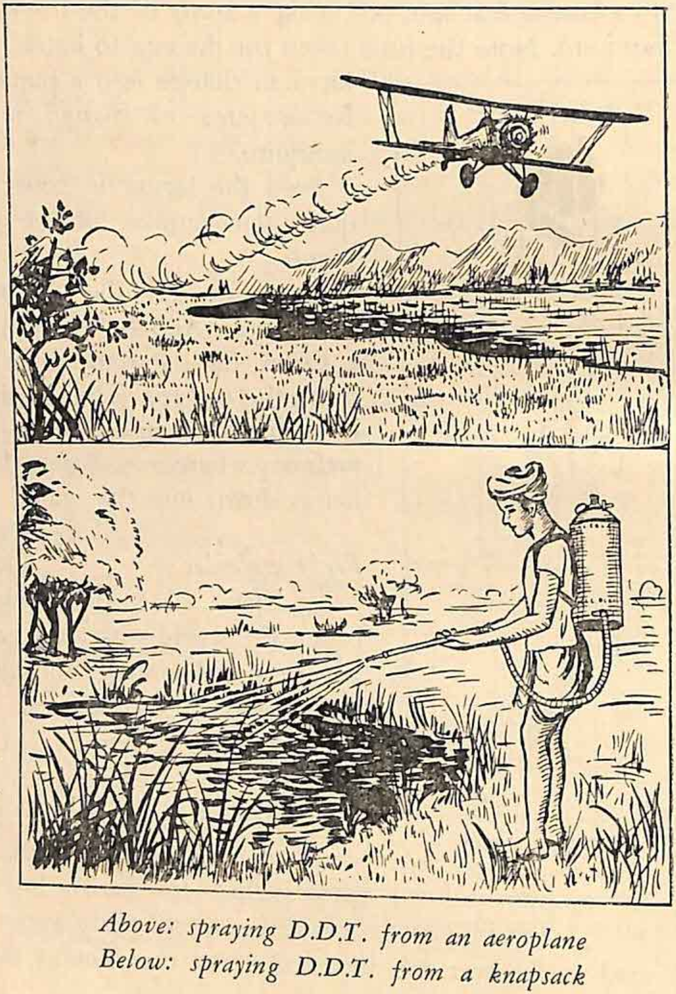
You can tell the difference between an Anopheles larva and a Culex larva by the way they lie at the surface. An Anopheles larva lies horizontally under the surface, whereas a Culex larva hangs down into the water.

Fight malaria:

In April 1953 our country began the world's greatest battle against the Anopheles mosquito. To-day the battle continues.

A chemical known as D.D.T. is used very extensively to kill mosquitoes. It is sprayed by men carrying special machines. In places that are badly infested with the pest aeroplanes are often used to fly over the area and spray the ground below with D.D.T.

Oil is sometimes used instead of D.D.T. It is sprayed over a tank. You already know that larvae cannot breathe the air



Above: spraying D.D.T. from an aeroplane
Below: spraying D.D.T. from a knapsack

dissolved in water as the fishes do, but instead must rise to the surface to breathe. If oil covers the surface of the tank they die of suffocation.

In some tanks certain kinds of fishes that eat mosquito larvae have been introduced.

In this big fight against the mosquito you can also help. Here is a list of things to do:

1. Never allow water to stand in tins, vases, bottles, buckets and other vessels.
2. If there is a swamp in your neighbourhood dig a drain for the water to flow away.
3. Spray kerosene oil over stagnant water using a watering-can.
4. Drain away the water from pools and puddles and fill them with sand.
5. Be sure that no rubbish collects around your house. Mosquitoes hide in such places during the day.
6. Always sleep under a mosquito-net and see that it is carefully tucked in.

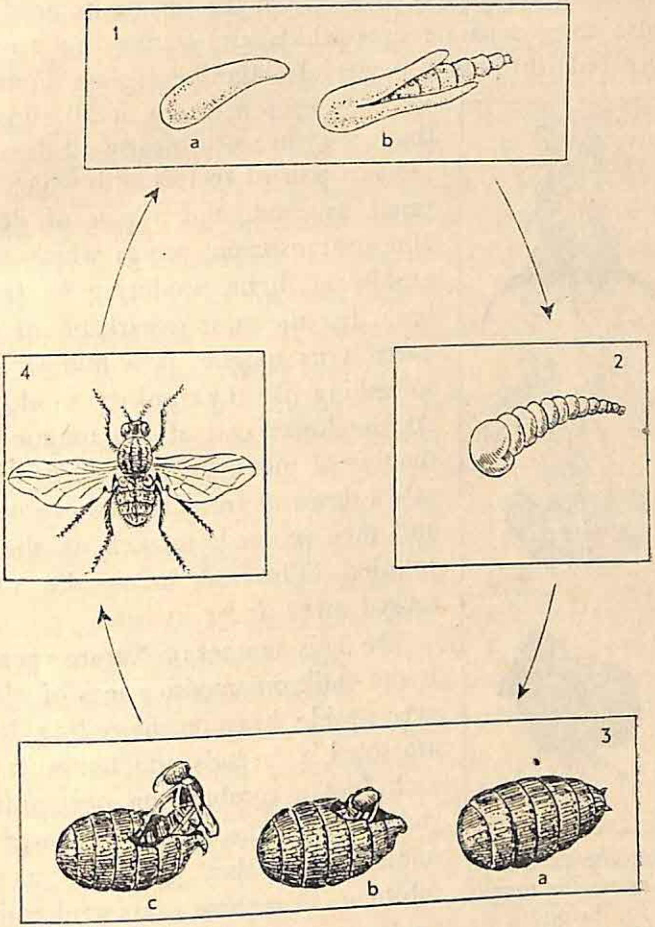
13

Two Household Pests

THE fly and the cockroach are certainly two of the most unpopular insects that visit a house. In every land, the householder tries to match his wits against the nimbleness of these little creatures. Year by year thousands are destroyed. What have the fly and the cockroach done to deserve such persecution? This question can be answered only after studying the lives they lead.

A fly is born and bred in filth. The mother fly lays about one hundred and fifty, white, cigar-shaped eggs on a manure or rubbish heap, for that is the sort of material on which her babies will feed. In a few hours, slender, white maggots hatch from the eggs. A maggot has no legs and no head. It has a mouth, however, and feeds greedily, casting off its skin on two separate occasions. Within a few days it changes into a brown barrel-shaped pupa which eats nothing and remains quite still. Inside the pupa a fly forms. When it is quite ready to make its appearance, the fly forces its way out, waits a few moments for its wings to dry, and then off it goes to become the unbidden guest at somebody's table.

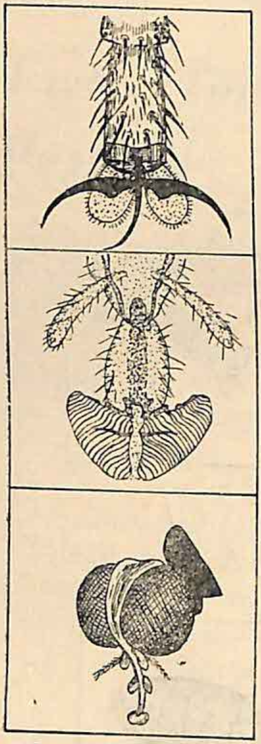
Try to get as close as you can to a fly and study it under a magnifying glass. You will not find this easy to do. On either side of the head are two brown globes which are made up of



Life-history of a fly

1. (*a*) *Egg.* (*b*) *Larva emerging from egg.* 2. *Larva.*
3. (*a*) *Pupa.* (*b, c*) *Fly emerging from pupa.* 4. *Adult.*

thousands of tiny six-sided eyes. On the top of its head there are also three separate eyes which are so tiny that they can be seen only through a powerful magnifying glass. Possessing so many eyes it is not at all surprising that a fly can see in nearly all directions. It has a pair of feelers with which it can smell its food, and a pair of delicate, almost transparent wings which vibrate rapidly in flight, producing its familiar buzz. But the most remarkable of all its parts is its tongue. It is hollow and is something like the trunk of an elephant. At the lower end of the tongue are a number of tubes. Before it feeds it sends saliva down its trunk to dissolve its food and then proceeds to suck up the food solution. When not in use the trunk is tucked away under its head.



Above: the foot of a fly. Centre: the tongue of a fly. Below: a fly feeding.

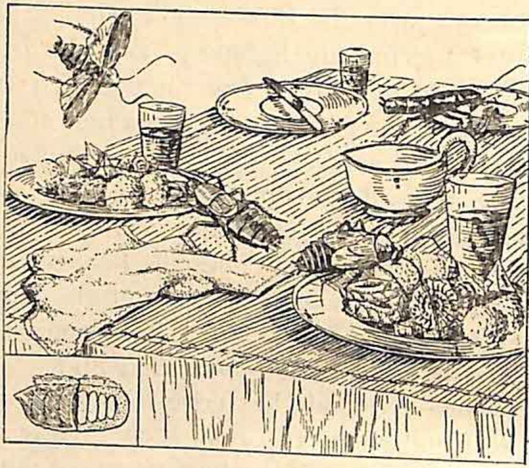
The fly is another of Nature's acrobats. It can walk on smooth panes of glass or even upside down on the ceiling. Its feet are soled with pads and hooks, making each foot a combination of tennis-shoe and ice-pick. The pads are covered with minute hairs that give out a sticky substance. It is these wonderful pads and hooks on its feet that enable it to cling easily on to any smooth surface and perform such marvellous feats.

All of us have seen a fly at its toilet. It appears to be very clean in its habits, but do not be deceived. The fly that is

hovering over the dining table, sipping the milk, tasting the sugar and making lightning raids on the food in your plate was probably only a few minutes ago enjoying the choicest morsels in the garbage can. Every now and then it stops to clean up, leaving its dirt behind. People call it a nuisance, but it is more than that — it is a danger to our health. Typhoid, cholera, dysentery, diarrhoea and tuberculosis are some of the diseases carried by the housefly. Because of the dirt and disease it carries, it has gained for itself the reputation of being the nation's Public Enemy No. 1. No wonder that the moment a fly is seen a cry goes out, 'Swat that Fly!'

When everybody has gone to bed cockroaches come out of cracks and crevices to hold their nightly supper parties. They scuttle along the floor, climb on to the dining table and search in the kitchen for something to eat. They have no special likes and dislikes in their choice of food, and will in fact eat almost anything. It is not very pleasant to know that whilst we are asleep cockroaches are wandering over dirt and rubbish and also on to any uncovered food. Because of their unpleasant habits, cockroaches have earned for themselves a bad name and are greatly disliked by the householder. Many of them meet their doom beneath his avenging shoe.

The cockroach has a sleek, brown covering which shines like patent-leather. It is flat in shape and is thus able to hide in chinks or squeeze itself under boxes. Sometimes you may see its two long feelers poking out of its hiding place. It waves these living threads about and tests everything with which it comes into contact. It bites its food with a pair of jaws which move from side to side when it eats. Like the fly, the cockroach is very careful about regularly making its toilet. Unfortunately, this creature also does not care where it cleans itself.



A Cockroach party
(Can you tell the males from the females)
Inset: an egg purse half open to show the eggs.

Only the male cockroach can fly. When not in use its wings are folded away beneath special wing covers, in straight folds like a hand-fan.

Mrs. Cockroach carries her eggs in a little brown, water-proof purse which she keeps just under the end of her belly. In the purse there are sixteen eggs arranged in two rows. When the eggs are about to hatch she puts them in a warm place. From each egg comes a tiny, white baby cockroach that resembles its parents in shape and general appearance. As it grows larger it casts its skin. After several years it becomes a full-grown insect.

The fly, cockroach and mosquito are three of our greatest foes. It is very necessary to know their habits and life-histories before you begin the task of destroying them. The health of your family and community depend on whether these disease-carriers are allowed to live in your neighbourhood. Do your best to get rid of them and their young.

Things to make and do

In and around your home:

Always keep your house clean. Clear the table immediately after a meal. Both dining and kitchen tables must be washed thoroughly every day. Food must be covered with muslin or kept in special wire-mesh cupboards. Never allow rubbish to collect, for it is here that flies and cockroaches live and breed. Cracks in the floor and walls should be filled.

In spite of all your efforts a few flies may enter your house. They should be killed by using fly paper, spray-guns or swatters.

Always keep your compound clean. Remove rubbish and burn it. If there is a dust-bin nearby, see that the lid is always kept tightly shut.

For your wall newspaper:

Prepare posters that illustrate how the fly is a danger to health. Write a slogan on the poster you design.

In your note-book:

1. Describe in detail how a fly makes its toilet.
2. Make a list of insecticides that kill flies and cockroaches.
3. Try to catch a baby cockroach. Keep it in a bottle and feed it on bits of bread. Cover the top of the bottle with mosquito-netting. Describe how it sheds its skin.

For your museum:

1. Collect the egg-purse of a cockroach.
2. Look for the cast-off skin of a cockroach. Cracks in the furniture or walls are likely places where you might find them.

14

Spinners, Hunters and Trappers

'WHAT A NUISANCE ! — another cobweb !' exclaims mother and makes quite certain that it is swept away immediately. Somebody ties a broom to the end of a long pole and then, with a single sweep of the broom, the work of Nature's finest spinner is no more. Though a cobweb is an ugly thing to have hanging on our walls, nevertheless, we cannot but admire the skill of the little spider who built it.

You may often hear the spider spoken of as an insect, but this is not correct. An insect has six legs, whereas a spider has eight. Moreover, an insect has its body divided into three parts. A spider, however, has its body divided into two parts. The head and chest are united together to form the front part; the second part of the body is the belly.

Catch a spider by throwing a handkerchief over it. Imprison it in a bottle and study it under a mangnifying glass. Although there are eight eyes on its head, it is a curious fact that the creature cannot see very well. It relies more upon its sense of touch than upon its eyesight. At the front of its head are two powerful jaws, which, like the blades of a pen-knife, fold inwards when not in use. Each jaw is a poison fang. On either side of the jaws are two jointed parts which are used by the spider to catch and hold its prey while feeding.

1. *A Spider's head (e, eyes; f, fangs)*
2. *The end of a spider's foot*
3. *The spinnerets*
4. *The tubes on a spinneret*

Four pairs of jointed legs grow from the front part of a spider's body. Each leg ends in a claw that bears teeth on one of its edges giving it the appearance of a tiny comb.

The spider's silk comes from two or three pairs of spinnerets situated in the lower part of its belly. A spinneret is shaped like a finger and at the tip are a number of minute tubes. Silk is squeezed out of these tubes and comes out as a liquid that hardens immediately on contact with the air to form fine strands. The strands unite together to form a single thread.

The web of the house spider is an untidy mass of tangled threads. It is usually built in the angles of ceilings and remains invisible until laden with dust. But in the garden you will see the web of the garden spider which is beautifully designed in the shape of a cartwheel. Watch a spider build its web and you will learn a lesson in patience.

The female spider builds a better web than the male. During the monsoon she may build a fresh web every day, either at night or in the early morning. She begins her web by lifting her belly in the air and paying out a thread of silk that floats away in the breeze. When the thread touches a

neighbouring object it sticks and the spider pulls in the line till it is taut. In this way a fine suspension bridge is made. She crosses over to the other end of the bridge and with the help of the claws on her two back legs, positions and fastens the thread. She then drops into space, suspending herself by a thread. Down she goes until she reaches another twig where the line is fastened. Two sides of the framework have now been made. In similar fashion the remaining sides are completed.

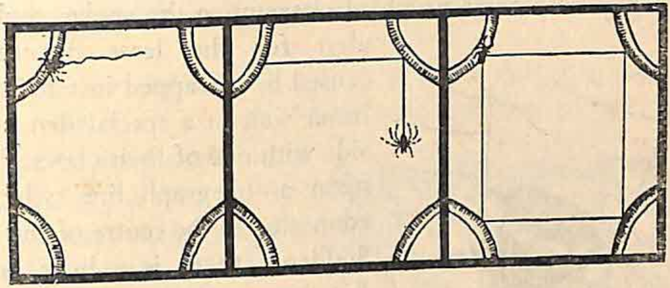
The spider next goes to the middle of her bridge and drops to some point below. Here she fastens the thread and climbs back up the same thread to the centre of the web. At the centre she fastens the thread and then continues her climb to the top taking care to hold the line clear from the other threads of the web. Arriving at the top she chooses a suitable spot to fasten the thread of the new spoke. Then back and forth she goes from the centre to the framework until all the spokes are laid.

The work of laying the spiral now begins. The spider starts from the centre and moves round and round until she reaches the framework. The spiral she lays is irregular and merely a temporary structure. It serves to keep the spokes in position and also acts as a foothold. Thereafter the permanent spiral is spun. It is laid very carefully. After it is completed she gathers up the threads of the first spiral and eats it so that it does not go to waste.

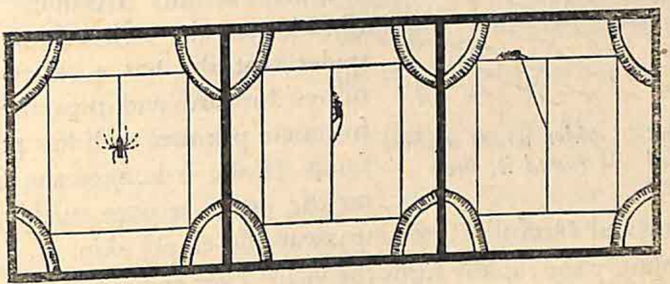
The spider produces two kinds of silk: one is dry, the other sticky. Only the spiral thread of a web is sticky. If you look at it under a magnifying glass you will see a number of gummy drops like a string of pearls, placed at regular intervals along its length. A spider's body is oily and it is due to this that she does not become entangled in her own web.

Some spiders stay in the centre of the web waiting for their

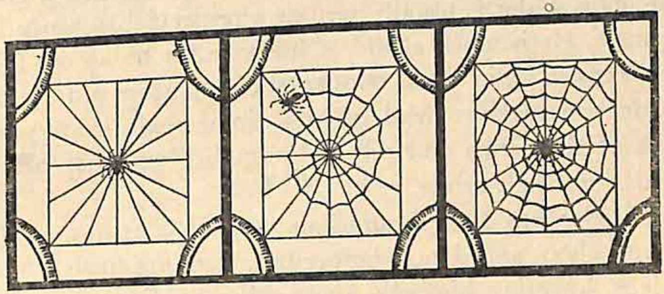
How the spider makes her web



First the framework is made

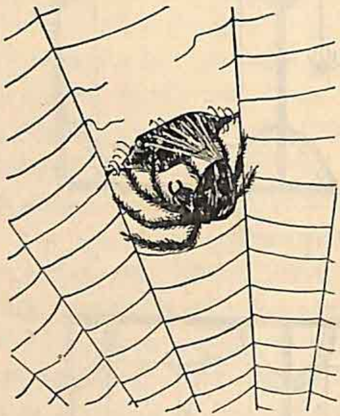


Then spokes are connected from the centre to the framework



Finally the spiral thread is spun to complete the web

prey. They keep their watchful claws upon the spokes and are alert for the least disturbance caused by a trapped insect. Others lie in wait in a special den at the side with one of their claws placed upon a 'telegraph line' which is connected to the centre of the web. Suddenly there is a buzz and a fluttering and the net is shaken violently as some snared insect struggles for its freedom. The vibration of the web informs the spider that she has a caller. She rushes forward and nips the unfortunate prisoner with her poison fangs. If she is hungry she feeds on the insect at once, sucking its blood, and carefully throwing away the empty skin. If she is not hungry she rapidly turns the victim over and over, wrapping it at the same time in a sheet of silk. She then leaves it in one corner of the web, returning at her leisure to suck its blood.



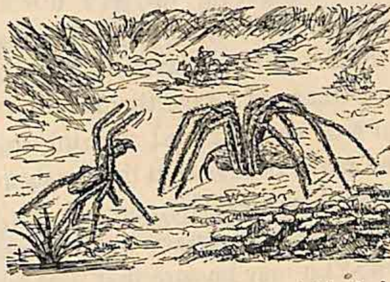
How the spider wraps a sheet of silk round its prey

The male spider is usually seen at a respectful distance from the female. He is much afraid of his wife for he knows that if she happens to be in a bad temper, she may make a dash in his direction and make a meal of him. Some male spiders make no web of their own and rely only on the food they are able to steal from their wives.

Mr. Spider has a most amusing way of courting his lady. He jumps about and dances before her, standing upright on his back legs, lowering his belly and raising his front legs. Then he runs around her in circles. If she does not like the

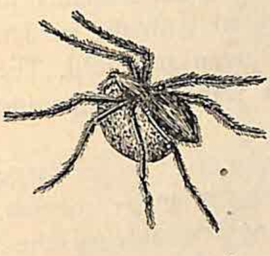
way he dances, she will pounce upon him, kill him, and suck his body.

The mother spider lays hundreds of eggs and rolls them into a ball, meanwhile covering them with a silken cocoon. Some mothers leave their cocoons in the crevice of a wall or tree; others carry their cocoons about with them attached to their spinnerets. A spider of the latter kind is a very good mother indeed. She carries her babies on her back wherever she goes. Should any of her young ones fall off she has an anxious time until she has regained her little ones.



Mr. Spider dancing before his lady

Baby spiders look exactly like their parents. Some kinds of baby spiders go on a long journey before they settle down to build their webs. At first each spiderling climbs to a high spot where it lifts its belly and pours forth a stream of silk upon the air. The breeze blows the silken thread upwards and outwards. Soon the baby feels itself being pulled along by its thread in the direction of the breeze. It now releases its foothold, becomes air-borne and is carried away at the end of its thread on a voyage of discovery to unknown lands. When the thread becomes entangled with an object the young explorer begins to land. It draws in its life-line, and arriving at its new home builds a web. If a large number of spiders descend together, their silk threads,

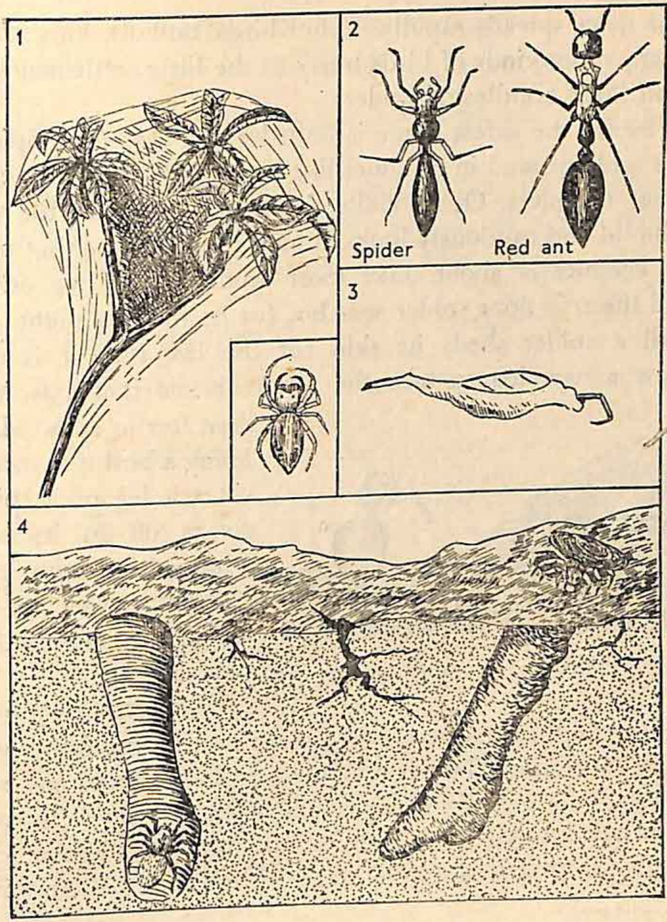


Mrs. Spider and her cocoon

called gossamer, carpet the fields. In the early morning when the veil of gossamer is drenched with dew it is a lovely sight. Now it looks like a fairy carpet, shimmering in the sunshine, parts of it glistening with rainbow colours. The rays of light that strike it go wandering up and down the delicate silver threads, sparkling at certain points like jewels in the sun.

Spiders are a favourite delicacy with many lizards, birds and wasps. To save themselves from their enemies they do all sorts of cunning and amazing things. Some of them are actors and make believe that they are something entirely different from what they are. They do not act for enjoyment but to deceive their foes. A certain kind of spider disguises itself as a red ant. You may be sure that lizards and birds keep a safe distance away from this clever pretender. Another kind of spider drops to the ground when disturbed. It curls up its legs and pretends to be dead. A rather rare spider, found in our country, performs a vanishing trick whenever its foes are about. It closely resembles a green leaf in appearance and so finds no difficulty in disappearing from view. We are all familiar with the garden spider which is clad in a coat of bright green and gold. The colours of its coat match the colours of leaves and ripening fruits.

When winter is drawing to a close you may often see large balls of dead leaves and twigs bound together by cobweb. Within each ball are scores of spiders, living peaceably together. Woe betide the insect unlucky enough to fall into the clutches of this murderous company. The occupants immediately swarm out of their nest to meet the stranger and devour it. The nest built by these spiders is somewhat similar to that built by a kind of red ant, and so deceives the birds. If, however, the birds discover that harmless spiders are the inhabitants of this leafy



How spiders protect themselves
1. *A spider settlement (Inset: an inhabitant of the settlement).*
2. *A spider that looks like a red ant.* 3. *A leaf-like spider.*
4. *The Trap-door spider.*

nest the news spreads rapidly. Tailor birds, bulbuls, king crows and many other kinds of birds hurry to the little settlement and carry off large bundles of spiders.

But by far the safest home is built by the Trap-door Spider. It lives underground in a tunnel lined with silk which serves to keep out intruders. Occasionally the spider comes to the top, lifts the lid and cautiously looks around to make sure that none of its enemies is about. Like most animals that live underground the trap-door spider searches for its food by night.

Until a spider sheds its skin for the last time it is able to grow a new leg to take the place of one that may have been lost in an accident. Many a bird is surprised when a leg of a spider comes off in its beak while the victim goes scurrying away as fast as its remaining legs will carry it.

How the spider loses a leg to save its life

The members of the spider family that frequent a house are no less interesting than their jungle cousins. Two common kinds do not build any webs at all. There is a large fierce-looking creature very often seen hunting for cockroaches in dark rooms. Another common house spider is the little Jumping Spider which is fond of mosquitoes for its supper.

Although we should try to rid our houses of spiders, we must also realise that they catch and destroy countless insects which are injurious both to our health and to our food crops. Spiders, therefore, are friends, for in our continual warfare against insect pests they fight on our side.

Things to make and do

Outdoors:

1. Look for the web of a garden spider and watch how it catches its prey.
2. Try to find the cocoon of a spider.
3. Touch the spokes and spiral threads of a web with the point of a pencil. What difference do you notice?

For your wall newspaper:

Sketch the different kinds of spiders found in a house.

In your note-book:

1. Describe what a spider does when a leaf becomes entangled in her web.
2. How does the spider tackle an insect which is larger than itself?
3. Draw a picture of a spider's 'larder'.

At Home:

Capture a house spider and keep it in a glass bottle. Cover the top of the bottle with mosquito-netting. Feed your prisoner on flies and study its behaviour. If you find a cocoon, keep it in a bottle covered with net and wait for the babies to appear.

15

A Little Kingdom

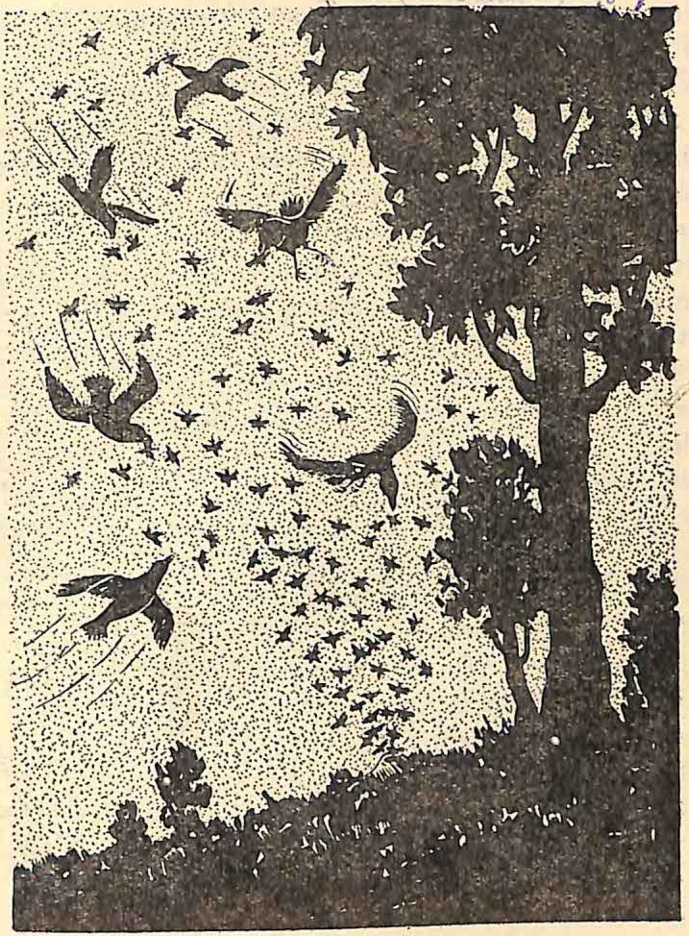
AFTER a heavy monsoon shower the stillness of an evening twilight is sometimes disturbed by a host of fluttering insects. They emerge from a tiny opening in the ground and then fly clumsily into the air forming a cloud.

Birds about to retire for the night are attracted immediately by the unexpected throng of insects and bear down upon them, uttering joyous cries. Soon the good news spreads. Animals come from far and wide, hastening towards the centre of attraction to attend the banquet. Lizards, bats, frogs, scorpions and squirrels are some of the many eager guests that arrive at the happy hunting ground. Everyone gobbles the insects greedily; in fact, the birds eat so much that they cannot close their beaks!

A good many of the insects are attracted by light and invade our homes. Somebody places a basin of water below a lamp and the insects tumble in to drown. Geckoes on the wall and spiders in their webs have a busy time.

Both indoors and outdoors hundreds of the insects are killed. But, somewhere in the gathering dusk, a few lucky ones escape. The males among the survivors go in search of brides. If a male finds a mate, he tears off her wings, while she does the same for him. Then the pair hurry off into the night, one behind the other in single file, to begin their family.

People speak of these insects as white ants but this is not

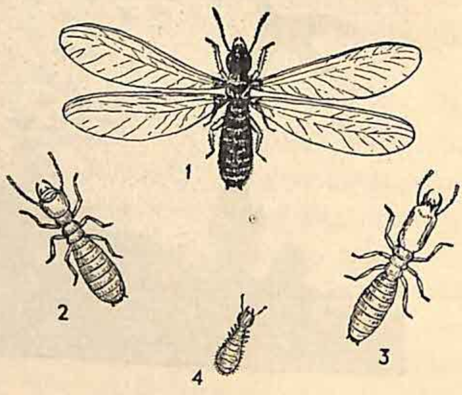


The flight of the termites

a good name for them. In the first place, they are not ants, and in the second place, they are not often white. The correct name for them is termites.

Soon after pairing, the male and female termites become the king and queen of a new home. They choose a suitable crevice in which to live and breed. The queen lays eggs and cares for the first batch of babies herself. Thereafter she is unable to do any more work, for she becomes too fat. She swells and swells until she is the size of a man's finger. For her life-span of ten years she remains in one spot, continuously laying eggs, sometimes laying them at the rate of an egg every second. Tiny baby termites come from the eggs. Some babies become workers, some become soldiers, while some become males and females.

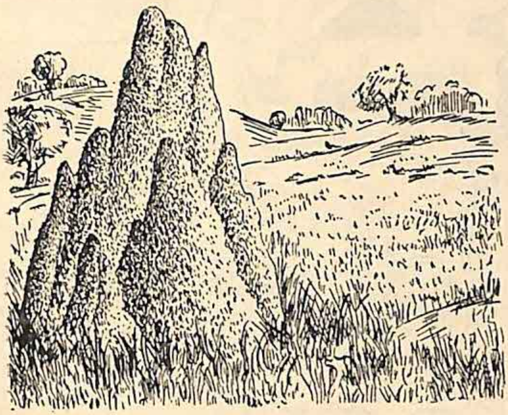
Both soldiers and workers are wingless and blind. A soldier is larger than a worker and has a hard head at the end of which is a pair of powerful jaws. The males and females are winged and look much alike. We may call them princes and princesses for when they are quite grown up they will fly away from their present home and begin a colony of their own.



Termites
(*about four times life size*)
1. *Winged insect.* 2. *Worker.*
3. *Soldier.* 4. *Baby.*

Some kinds of termites live below the ground, while others raise huge mounds of

earth called ant-hills. In a termite's house there are many rooms connected by tunnels. The workers of a termite colony are responsible for constructing the house. They remove particles of soil to make the various rooms and tunnels. Then they build the walls out of bits of soil and wood, cementing the two materials together with saliva from their mouths.

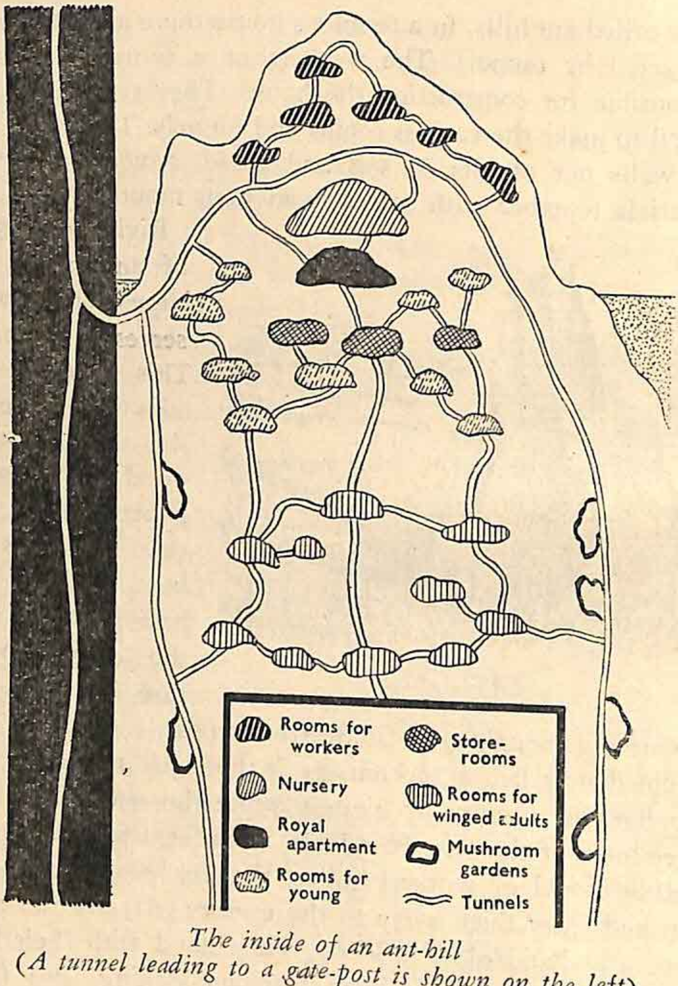


An Ant-hill

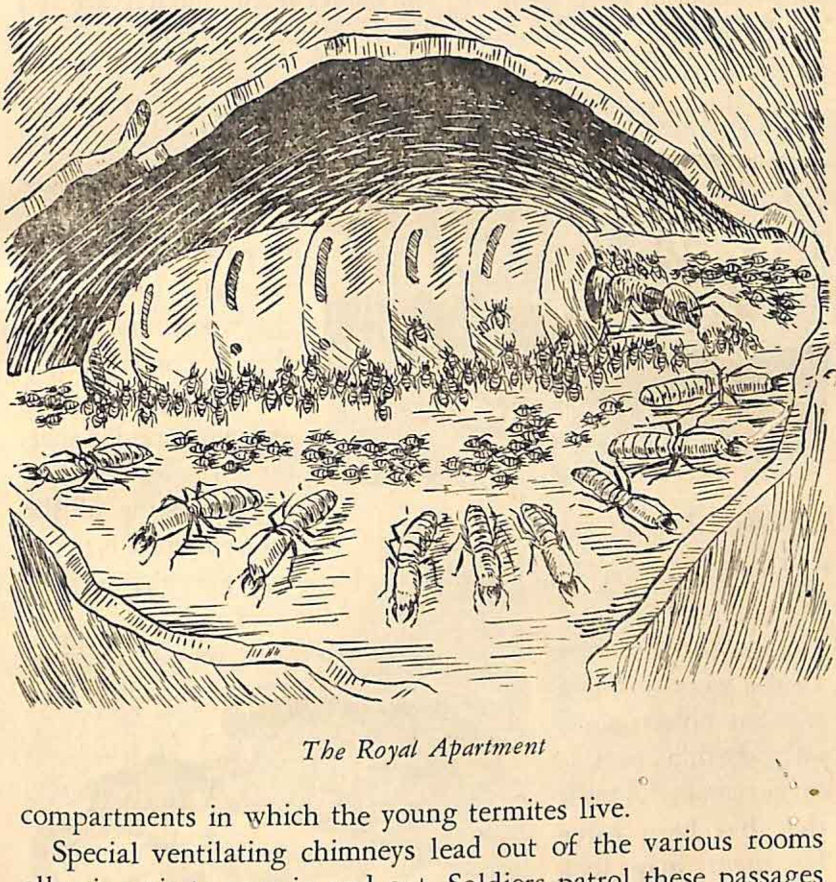
Right in the centre of an ant-hill is a large chamber which serves as a nursery. This chamber contains a number of shelves made of soft wood as thin as paper. On the shelves, the eggs are kept. When the babies come from the eggs, workers care for them until they are old enough to be transferred to other rooms.

Immediately below the nursery is the royal apartment. The king lives in a room by himself while the queen lives in a larger room at the side. Hundreds of workers feed the queen. Another crowd of workers collect the newly-laid eggs, wash them and carry them away to the nursery. Around the queen stands a body-guard of workers. They stand with their backs to their queen and their large fearsome-looking jaws facing outwards, ready to tackle a possible enemy.

Below the royal apartment are storerooms where the termites keep tiny bits of wood. Round the storerooms are other



The inside of an ant-hill
(A tunnel leading to a gate-post is shown on the left)



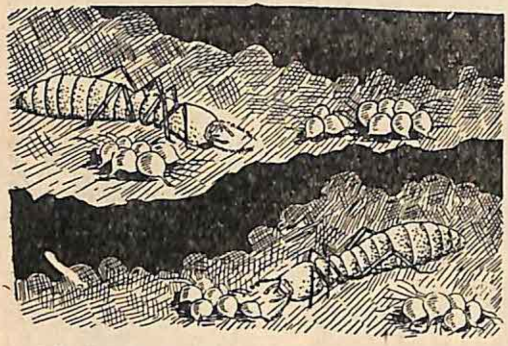
The Royal Apartment

compartments in which the young termites live.

Special ventilating chimneys lead out of the various rooms allowing air to pass in and out. Soldiers patrol these passages day and night, guarding them from intruders. Tunnels connect the bottom of the house to trees or to the walls of a building. A few of the tunnels go deep down into the earth, where there is water. The workers drink as much as they can and bring it up in their bodies for the others. Along the sides of the tunnels that lead to the water-supply, workers grow

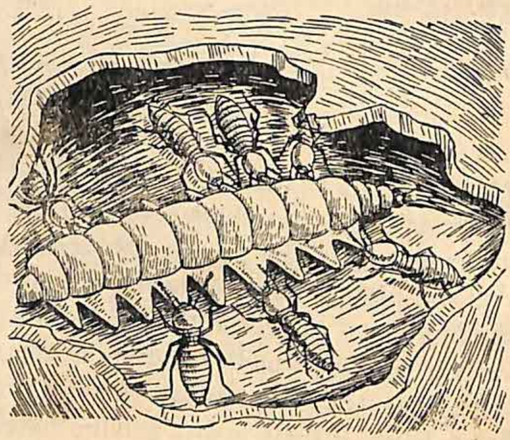
mushrooms in little gardens. The babies in the nursery are fed solely on these mushrooms until their jaws are strong enough to chew wood.

All the termites in the colony feed on dead wood. The food is collected by the workers. They tunnel up a dead tree or an article of furniture and then gnaw the wood. Sometimes they construct a covered way of mud and work under shelter of this earthen gallery. Some of the chewed wood is taken to feed the queen, king, soldiers and young ones; the surplus is stored.



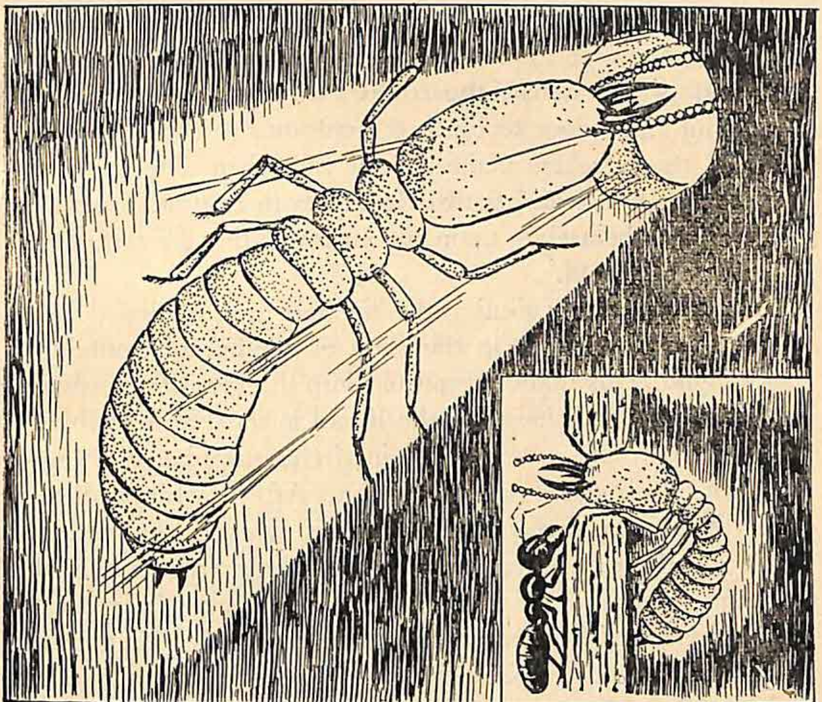
Workers in their mushroom garden

The workers chew all the wood inside a wooden object, until only a thin outside layer remains. A table that has been eaten by them may look quite solid on the outside but collapses and crumbles to dust the moment anything heavy is placed upon it. In our country



Workers and their pet

especially, termites do a great deal of damage and are, consequently, greatly disliked.



How a soldier termite defends its house

In certain rooms of their house the worker termites rear pets. These pets are tiny beetles which the workers care for and feed regularly. The beetles give off a sweet juice from their bodies. Workers eagerly gather around their pets and lick this substance. As the result of living in the darkness of a termite's dwelling the beetles lose their original colours and shapes.

Ants are the deadly foes of termites. Sometimes a group of ants may attempt to get into the termites' house. The moment a soldier termite hears the advance of the enemy it bangs the ground with its head. Soldiers near-by hear the signal and rush forward to help. If the ants succeed in making a tiny opening in a wall of the house, the soldiers at once use their heads as a living front door to block the entrance to their home. If, however, the attackers make a large hole then they pour into the termite's house and the battle begins in earnest. Troops of soldiers hurl themselves upon the enemy, biting fiercely, never releasing their hold.

In some termite colonies the soldiers are equipped with spray guns. The gun is in the form of a tube and contains a sticky liquid. This liquid is squirted into the face of the enemy. An ant receiving a charge of the liquid in its face is unable to fight any more and runs around in circles stopping every now and then to rub its face against a stone. After a while it dies.

As the battle proceeds the soldiers whistle for reserves. Their whistle is answered by another whistle from within the nest and more and more soldiers arrive to take the place of their dead comrades. Very rarely do the ants succeed in winning the battle, and they usually fly from the scene of their defeat, each carrying off two or three termite prisoners.

Once the danger has passed, the workers reappear to repair the damage and to carry away the brave soldiers who died in defence of their queen, the babies and the other termites in the house.

The story of the termite reads like a fairy tale. It is, however, just another example from nature of how certain creatures live together in colonies to protect themselves from their enemies. Every little termite knows the work it is expected to

do, and does it well, realising that all the others in its great family depend on its services, just as it, in its turn, depends upon theirs.

At a certain time of the year the princes and princesses swarm into the air, pair off, and choose a suitable spot to begin their own little kingdom, and the story begins once again.

Things to make and do

Outdoors:

Look for the covered galleries of termites on the surface of a dead tree. When you find a gallery break a part of it and watch what happens through a magnifying glass. How long do the workers take to mend the gallery you broke?

For your wall newspaper:

Make sketches of the following:

1. Termites fluttering around an electric bulb.
2. A pair of termites hurrying away to begin a new home.
3. A piece of wood that has been eaten by termites.
4. Soldier termites guarding a broken gallery.

In your note-book:

Write a few sentences describing the life led by (*a*) the king, and queen, (*b*) the workers, (*c*) the soldiers, and (*d*) the princes and princesses.

Make this model:

Mould a lump of clay or plasticine to show how an ant-hill looks when it is cut through lengthways. The picture on page 138 will help you.

1. *The Black Drongo defends its nest.*
2. *Golden Orioles.* 3. *Red Turtle-Doves.*

16

Watch The Birds!

As the first few rays of light steal across the sky, the birds wake up and joyously proclaim to the world that a new day has begun. If you rise early in the morning you will hear the sweet voices of Nature's choristers raised in song. They whistle and trill, and chirrup and twitter, pouring forth the joy that is bubbling over in their hearts. By the time the sun is well up in the sky however, they have ceased to sing and are attending to the business of the day.

The busiest time of the year for most of our field and garden birds is the summer. During this season they build their nests and spend many patient hours hatching their eggs. The babies are born in the early monsoon when insects are easily procurable.

The Black Drongo is often seen in the garden. You will know it by its glossy black plumage and long forked tail. Although no larger than bulbuls, both male and female birds are absolutely fearless. They will boldly defend their nest against the attack of a hawk, a crow or any other big bird, driving the intruder away with angry cries. On account of its dauntless courage people speak of the drongo as the king-crow.

Timid birds like the Golden Oriole and the Red Turtle-Dove sometimes nest in the same tree as that chosen by a pair of

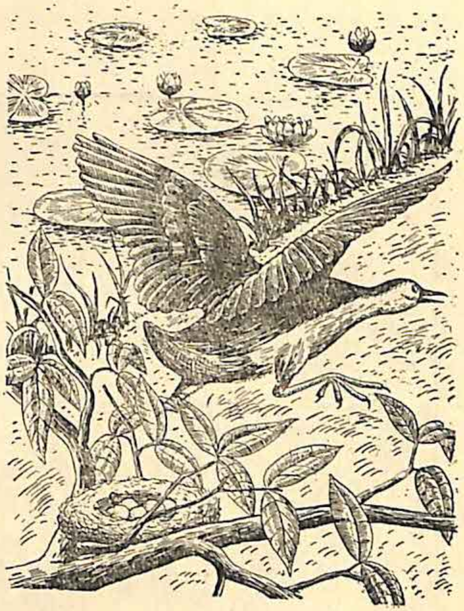
The Little Skylark

drongos and enjoy the free services of the ever-watchful sentinels above.

Have you ever wished you could fly away into the sky and gambol with the clouds? Watch the Little Skylark in the summer. You will find him in the countryside showing off before his mate. He soars skywards singing as he rises and soon disappears from view. High up in the sky he pauses for a while and continues his serenade. Then down he plunges closing his wings and dropping like a stone. When about thirty yards from the ground he brakes miraculously to a dead halt in mid-air. There he hovers for a few seconds, suspended on quivering wings, and finally returns to his starting point.

Water-birds build their nests usually along the margin of a tank or amongst floating vegetation. The nesting season is during the monsoon when the tanks are full, and insects, fish and frogs abound.

Egrets and herons nest in mixed companies on a large tree near the water's edge. Their colony is called a heronry. All through the day the babies beg for food and their parents have a very busy time indeed.

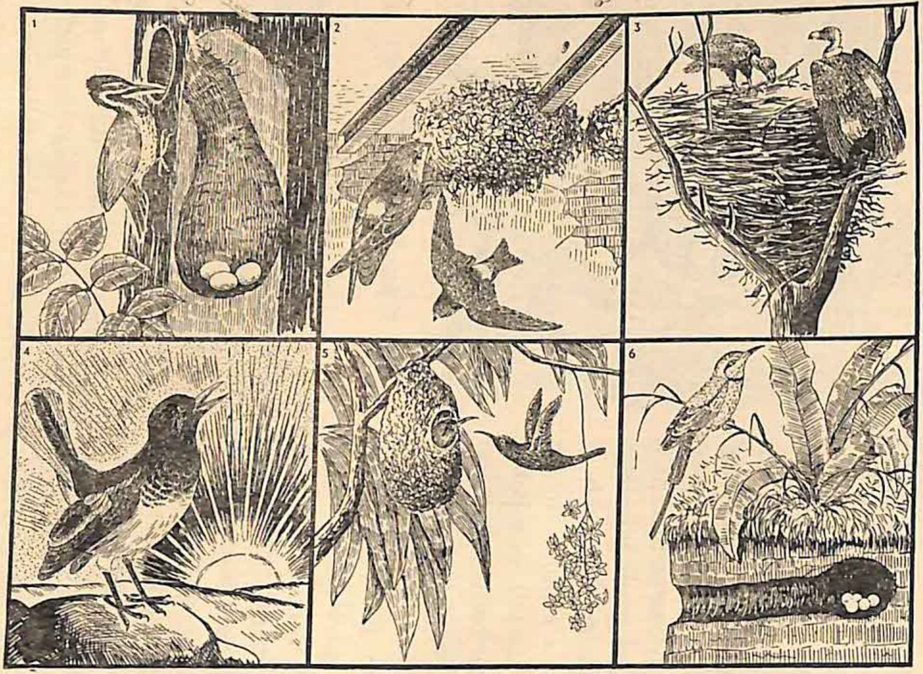


The White-breasted Waterhen

Swamps, flooded rice fields and the margins of tanks are the favourite haunts of the White-breasted Waterhen. In such places you will see this bird feeding in the open or skulking through the undergowth. It is about the same size as a partridge and is slaty-grey in colour with a white face and breast. Under its tail is a patch of bright rusty-red.

At the time of its nesting season the waterhen may be heard day and night giving its loud metallic call. It roars, grunts, croaks and chuckles, abruptly ending its call with a note that is repeated over and over again. If disturbed it gives a frightened squawk and half running, half flying, makes a dash for cover.

When the sun has dipped over the horizon and a night hush covers the land, when all the other birds have retired to rest, you may hear a blood-curdling scream shatter the silence of the night. It is in the voice of the Barn Owl, out searching among the shadows for its supper. Dimly, through a network of branches, it spies a small animal scurrying along the ground, partly hidden by the long waving grasses. Then silently and swiftly the bird swoops down upon its prey, seizes the



1. *Golden-backed Woodpecker.* 2. *House-Swift.* 3. *White-backed Vulture.*
4. *Magpie-Robin.* 5. *Sunbird.* 6. *Green Bee-eater.*

poor creature with its long, hooked claws and bears it away in triumph.

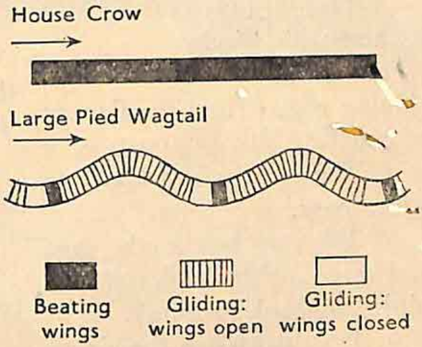
The Barn Owl attacks

Careful bird watching will provide you with many interesting sights all the year round. You will see the beautiful Golden-backed Woodpecker, dressed in its golden coat and crimson cap; the energetic House-Swift that builds an untidy nest of straw and feathers; the massive White-backed Vulture that repairs and re-occupies the same nest year after year; the perky Magpie-Robin that sings the first song of the day; the restless Purple Sunbird that constructs a pretty purse-like nest; and the graceful Green Bee-eater that digs a tunnel in which to nest. To learn something about these and other winged marvels is to make acquaintance with some of Birdland's most breathtaking miracles.

Things to make and do

For your wall newspaper:

Make flight patterns of the various kinds of birds. Two such patterns are shown here. The first pattern shows the straight flight of a House Crow. The second pattern shows the dipping flight of the Large Pied Wagtail. Use different colours to show whether the bird beats its wings or glides with wings spread or closed.



Flight patterns

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In your neighbourhood:

Study the birds that are to be found near your home. Carry a note-book with you for jotting down observations or making illustrations when out on your expeditions. Make a list of the different kinds of birds you see and describe their colour, size, behaviour and nesting habits.

Make a book of bird songs:

The Common Myna sings, KEEKY-KEEKY-KEEKY, CHURR-CHURR-CHURR, KOK-KOK-KOK. Write down the calls of other birds in this way.

In your note-book:

Copy the crossword puzzle on the opposite cover into your note-book. Then fill in the squares with the names of birds as indicated by the clues.

CLUES ACROSS:

1. It bobs its head from side to side and calls, TONK-TONK-TONK.

2. This bird very often binds its nest with wire.

3. Seen in the winter months sipping nectar from the flowers of the Red Silk Cotton tree.

4. The female bird lays two white eggs.

5. The crow hatches the eggs and cares for the babies of this bird (jumbled spelling).

6. It sails through the air on outstretched motionless wings (reversed spelling).

CLUES DOWN:

3. A great gossip.

7. You will often see this bird walking in a field in search of grasshoppers.

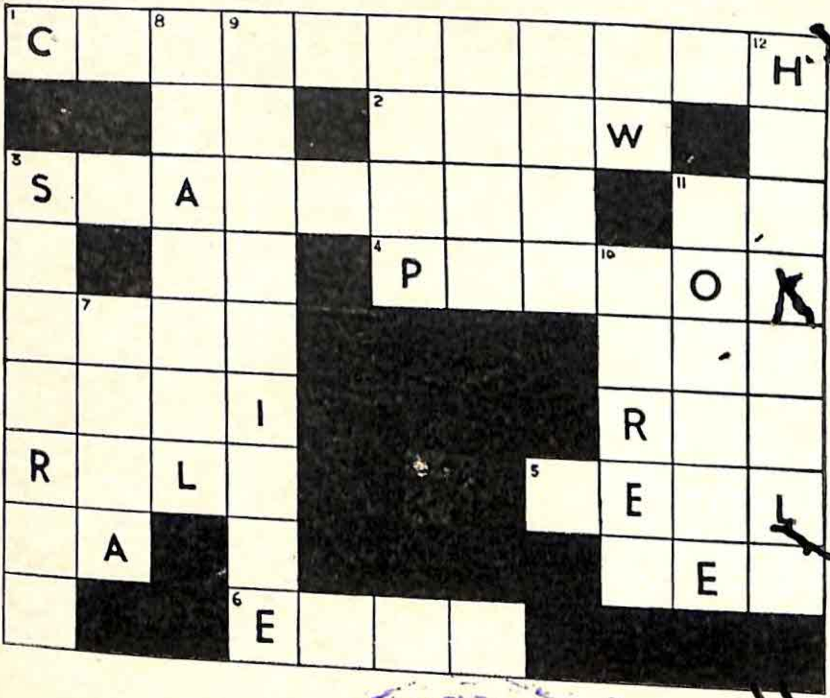
8. One of our jungle birds that is famous throughout the world for its beauty.

9. Many villagers make a pet of this bird.

10. A lanky snow-white bird.

11. When excited it raises its crest.

12. The female bird imprisons herself in the hollow of a tree whilst hatching her eggs.



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